

Hanford Tank Farms Vadose Zone Monitoring Project

Quarterly Summary Report for Second Quarter Fiscal Year 2005

May 2005



U.S. Department
of Energy



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May 2005

Prepared for
U.S. Department of Energy
Office of Environmental Management
Grand Junction, Colorado

Prepared by
S.M. Stoller Corp.
Grand Junction, Colorado

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**Hanford Tank Farms Vadose Zone Monitoring Project
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Prepared by:



A.W. Pearson
S.M. Stoller Corporation, Hanford



Date

Concurrence:

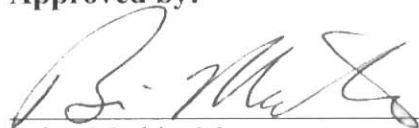


R.G. McCain, Hanford Technical Lead
S.M. Stoller Corporation, Hanford

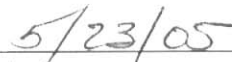


Date

Approved by:



Brian Mathis, Manager
S.M. Stoller Corporation, Hanford



Date

1.0 Introduction

The Hanford Tank Farms Vadose Zone Monitoring Project (VZMP) was established in fiscal year (FY) 2001 for comprehensive routine monitoring of existing boreholes in Hanford single-shell tank farms. The logging system used for monitoring is the Radionuclide Assessment System (RAS). A baseline record of existing contamination associated with gamma-emitting radionuclides in the vadose zone was established between 1995 and 2000 using the Spectral Gamma Logging System (SGLS). Although less precise, the RAS is a simpler, faster, and more cost-effective logging system than the SGLS. Measurements collected with the RAS can be compared to the baseline data to assess the long-term stability of the radionuclide contaminant profile. When routine monitoring identifies anomalies relative to the baseline, these anomalies may be investigated using the SGLS, the High Rate Logging System (HRLS), and/or the Neutron Moisture Logging System (NMLS). The HRLS is also used to collect data in boreholes where the contaminant activity exceeds the working range of the RAS instrumentation (greater than about 100,000 picocuries per gram [pCi/g] cesium-137 [^{137}Cs]).

During FY 2003, monitoring in boreholes associated with individual tanks undergoing retrieval operations was added to the work scope detailed in the original VZMP planning documents. Retrieval monitoring requirements for specific tanks are under development but include a pre-retrieval baseline measurement, monthly measurements during the retrieval operations, and monthly measurements for 6 months after retrieval operations cease. Both RAS and NMLS measurements are required for monthly monitoring, and monthly monitoring is supplemented by manual moisture measurements acquired by CH2M HILL Hanford Group, Inc. (CH2M HILL) personnel over limited depth intervals once or twice per week. During FY 2004, one new retrieval project (tank S-102) was initiated. Monitoring for two retrieval projects initiated in FY 2003 (tanks C-106 and S-112) continued into FY 2005. A lack of resources (i.e., RAS) diverted from the routine monitoring to retrieval monitoring negatively impacts the achievement of VZMP goals as originally set forth in 2001. Deployment of the NMLS to support retrieval operations requires an additional logging engineer and reassignment of the system from support for the RI/FS work conducted by the Department of Energy, Richland Operations Office (RL).

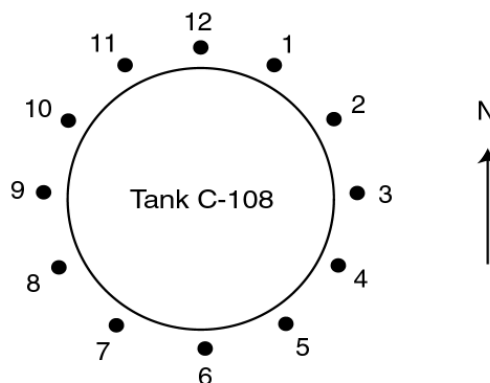
Routine quarterly reports are issued to summarize the results of monitoring activities, to provide the status of any ongoing special investigations, and to provide an updated listing of borehole intervals where monitoring is planned in the coming months. This quarterly report summarizes both routine and retrieval monitoring activities for the 2nd quarter of FY 2005 and includes project-to-date results where appropriate. Retrieval monitoring is segregated from routine monitoring so that the impact to the latter can be considered.

For readers not familiar with the Hanford Tank Farms borehole-numbering scheme, the following illustration shows how to identify the location of a borehole from its identification number:

Tank Farm Numbering Scheme

A Farm	10
AX Farm	11
B Farm	20
BX Farm	21
BY Farm	22
C Farm	30
S Farm	40
SX Farm	41
T Farm	50
TX Farm	51
TY Farm	52
U Farm	60

Tank Farm Borehole Numbering Scheme



Boreholes are identified by numbers using the format FF-TT-PP, where "FF" = tank farm, "TT" = tank, and "PP" = the position around the tank in a time-clock numeral from 1 to 12 (12 = north). For example, borehole 30-08-02 is in the C Tank Farm, around tank C-108, and at approximately the 2 o'clock position.

2.0 Monitoring Results

Summaries of monitoring operations for the 2nd quarter of FY 2005 and project-to-date are included in Table 2-1.

Table 2-1. Summary of Monitoring Operations for 2nd Quarter of FY 2005

Month	January	February	March	FY05 Total	Project-to-Date Total
Routine Monitoring Events (RAS)	1	3	3	7	857
Retrieval Monitoring Events (RAS)	0	3	1	4	114
Total RAS Events	1	6	4	11	971
Total NMLS Events	7	0	0	23	111
Total RAS & NMLS Events	8	6	4	34	1082
Routine Main Log Footage (RAS)	70	165	170	395	47972
Routine Rerun Log Footage (RAS)	0	10	10	20	2278
Retrieval Main Log Footage (RAS)	0	284	93	377	11704
Retrieval Rerun Log Footage (RAS)	0	10	0	10	280
Retrieval Main Log (NMLS)	717	0	0	2496	12231
Retrieval Rerun Log (NMLS)	70	0	0	225	1105
Total RAS Footage	70	469	273	812	63036
Total NMLS Footage	787	0	0	2721	13336
Total RAS & NMLS Footage	857	469	273	3533	76372

Appendix A includes tables that provide further details of boreholes monitored during the 2nd quarter of FY 2005. Table A-1 presents boreholes/events for routine monitoring performed with the RAS. Table A-2 presents boreholes/events for retrieval monitoring performed with the RAS. Table A-3 presents boreholes/events for the NMLS retrieval logging. These tables are derived from the project's monitoring database, which is continually updated as boreholes are monitored (DOE 2003). Boreholes are selected by a priority score (total score) that emphasizes proximity to tanks with significant drainable liquid remaining, and/or the presence of contaminant plumes, or where possible contaminant movement is suspected. The most significant change that occurs in the database is the monitoring frequency. Where monitoring results suggest possible contaminant movement, the monitoring frequency may be increased and depth intervals may be changed. Monitoring frequencies have also been increased to reflect the monthly monitoring requirement for retrieval operations in C and S Farms. Some lower priority boreholes are also selected for monitoring. This re-prioritization included boreholes in the vicinity of tank AX-103, which experienced a liquid-level decrease in a liquid observation well (LOW) during the previous reporting period.

The following sections describe the routine monitoring performed in each tank farm. In the interest of brevity, plots for boreholes where no apparent change was observed will not be included in this report. These logs are available on request. Table 2-2 lists boreholes that have shown indications of possible changes to the radionuclide contaminant profile. The appendix containing maps of the individual tank farms with locations of the monitoring boreholes has been omitted from this report due to the lack of routine monitoring. The only change would have been an update to the AX Farm map to include the initial monitoring in four boreholes associated with tank AX-103.

Table 2-2. Summary of Monitored Boreholes Indicating Radionuclide Contaminant Profile Changes

Tank Farm	Borehole Number	Radio-nuclide	Deter-mined	Number of Events	Assessment	Assigned Frequency	Qtrly/Annual Report
BX	21-12-02	⁶⁰ Co	09/23/03	3	Possible decrease	6 mos.	FY 2003
BX	21-27-08	²³⁸ U/ ²³⁵ U	03/13/02	5	Not confirmed	6 mos.	2 nd 2002
BY	22-03-04	⁶⁰ Co	11/15/01	4	Not confirmed	6 mos.	1 st 2002
BY	22-07-02	⁶⁰ Co	11/29/01	3	Not confirmed	6 mos.	1 st 2002
BY	22-07-05	⁶⁰ Co	12/12/01	3	Not confirmed	6 mos.	1 st 2002
BY	22-08-05	⁶⁰ Co	03/30/99	4	Not confirmed	6 mos.	1 st 2002
C	30-06-10	⁶⁰ Co	03/03/97	8	Definite change	1 mos.	FY 2004
C	30-08-02	⁶⁰ Co	09/11/02	8	Definite increase	1 mos.	FY 2004
C	30-08-03	?	01/21/03	3	Not confirmed	3 mos.	FY 2003
S	40-02-03	¹³⁷ Cs	07/09/03	1	Definite increase	1 mos.	FY 2004
SX	41-02-02	¹³⁷ Cs/ ⁹⁰ Sr	09/07/01	5	Not confirmed	6 mos.	FY 2001
SX	41-10-01	¹³⁷ Cs	02/11/03	4	Possible increase	6 mos.	FY 2003
SX	41-15-07	¹³⁷ Cs	02/12/03	2	Not confirmed	6 mos.	FY 2003
T	50-01-09	⁶⁰ Co	07/30/01	5	Not confirmed	6 mos.	FY 2001
T	50-02-05	¹³⁷ Cs	05/19/03	4	Not confirmed	6 mos.	FY 2003
T	50-06-02	⁶⁰ Co/ ¹⁵⁴ Eu	07/18/01	5	Not confirmed	6 mos.	FY 2001
T	50-06-03	⁶⁰ Co	07/18/01	5	Not confirmed	6 mos.	FY 2001
T	50-06-18	⁶⁰ Co	09/03/02	5	Possible increase	3 mos.	FY 2002
T	50-04-10	⁶⁰ Co	01/28/02	5	Possible confirmation	3 mos.	2 nd 2002
T	50-09-01	⁶⁰ Co/ ¹⁵⁴ Eu	07/23/01	5	Not confirmed	6 mos.	FY 2001
T	50-09-02	⁶⁰ Co	01/08/02	3	Not confirmed	12 mos.	2 nd 2002
T	50-09-10	⁶⁰ Co/ ¹⁵⁴ Eu	07/23/01	5	Not confirmed	6 mos.	FY 2001
TX	51-03-11	⁶⁰ Co	05/20/02	2	Possible increase	6 mos.	3 rd 2002
TY	52-03-06	¹³⁷ Cs	05/02/02	5	Definite change	3 mos.	3 rd 2002
TY	52-06-05	⁶⁰ Co	05/14/02	3	Possible increase	3 mos.	3 rd 2002
TY	52-06-07	⁶⁰ Co	05/22/03	2	Not confirmed	12 mos.	FY 2003
U	60-04-08	²³⁸ U/ ²³⁵ U	07/16/01	8	Not confirmed	6 mos.	FY 2001
U	60-05-05	²³⁸ U/ ²³⁵ U	08/27/02	5	Possible increase	6 mos.	FY 2002
U	60-07-01	²³⁸ U/ ²³⁵ U	07/12/01	8	Not confirmed	6 mos.	FY 2001

2.1 A Tank Farm

Routine monitoring was not performed in A Tank Farm during the 2nd quarter of FY 2005. To date, 31 of 52 (60%) boreholes in A Farm have been monitored at least once since the baseline was complete. The date of the last routine monitoring event in A Farm was 6/12/03.

2.2 AX Tank Farm

A total of 7 boreholes located around tank AX-103 were monitored during the 2nd quarter of FY 2005. To date, 16 of 31 (52%) boreholes in AX Farm have been monitored at least once since the baseline was complete. The date of the last routine monitoring event in AX Farm was 03/02/05.

An LOW scan in tank AX-103 recorded a liquid level drop of 2.7 inches on 12/12/04. This decrease in liquid level was confirmed with an additional scan on 12/16/04. A "Problem Evaluation Request" (PER), PER-2004-6221, was initiated on 12/20/04 by CH2M HILL to

address the issue. At the end of December 2004, a tank leak assessment was initiated; Stoller was asked to provide existing RAS data from tank AX-103 and to plan to monitor all the drywells surrounding tank AX-103. The seven boreholes surrounding tank AX-103 (11-01-09, 11-03-02, 11-03-05, 11-03-07, 11-03-09, 11-03-10, and 11-03-12) were all monitored once with the RAS during the 2nd quarter of FY 2005. Evaluation of the data indicated there were no changes to the gamma profiles in these boreholes. This work is discussed in further detail in Section 4.1, "Tank AX-103 Leak Assessment."

The 7 boreholes logged in the vicinity of tank AX-103 are reported as routine monitoring, primarily because they are not associated with any retrieval operation. However, they were selected for logging on the basis of the PER, which indicated a possible loss of liquid from tank AX-103. No routine monitoring activities were conducted in accordance with the priority scheme discussed in the monitoring plan. Even with the possibility of a recent leak, it required almost three months to complete logging in 7 boreholes, because operators were allocated to other projects.

2.3 B Tank Farm

Routine monitoring was not performed in B Tank Farm during the 2nd quarter of FY 2005. To date, 22 of 53 (42%) boreholes in B Farm have been monitored at least once since the baseline was complete. The date of the last routine monitoring event in B Farm was 4/21/03.

2.4 BX Tank Farm

Routine monitoring was not performed in BX Tank Farm during the 2nd quarter of FY 2005. To date, 50 of 74 (68%) boreholes in BX Farm have been monitored at least once since the baseline was complete. The date of the last routine monitoring event in BX Farm was 10/6/03.

2.5 BY Tank Farm

Routine monitoring was not performed in BY Tank Farm during the 2nd quarter of FY 2005. To date, 52 of 70 (74%) boreholes in BY Farm have been monitored at least once since the baseline was complete. The date of the last routine monitoring event in BY Farm was 11/12/03.

2.6 C Tank Farm

Routine monitoring was not performed in C Tank Farm during the 2nd quarter of FY 2005. To date, 57 of 67 (85%) boreholes in C Farm have been monitoring at least once since the baseline was complete. The date of the last routine monitoring event in C Farm was 2/20/04.

Four of the eight boreholes associated with the C-106 Waste Retrieval Project were monitored with the RAS during the 2nd quarter of FY 2005. The remaining four boreholes will be monitored as soon as CH2M HILL can provide the resources to operate the system. This will be the final round of monitoring associated with the C-106 Retrieval Project. The post-retrieval round of moisture logging was performed on the boreholes associated with the C-106 Retrieval

Project during the 1st quarter of FY 2005. This work is discussed in detail in Section 3.1, “Tank C-106 Retrieval Monitoring.”

Although the monitoring plan specifies monthly monitoring, only half of the 8 boreholes associated with the tank C-106 retrieval effort were monitored even once during the quarter. This is because operators required for the RAS are routinely assigned to other work.

2.7 S Tank Farm

Routine monitoring was not performed in S Tank Farm during the 2nd quarter of FY 2005. To date, 44 of 72 (61%) boreholes in S Farm have been monitored at least once since the baseline was complete. The date of the last routine monitoring event in S Farm was 10/8/03.

Boreholes associated with the S-112 Waste Retrieval Project were neither monitored with the RAS nor logged with the NMLS during the 2nd quarter of FY 2005. This work is discussed in detail in Section 3.2, “Tank S-112 Retrieval Monitoring.”

Boreholes associated with the S-102 Waste Retrieval Project were not monitored with the RAS during the 2nd quarter of FY 2005. The second round of moisture logging for these boreholes was completed during the 2nd quarter of FY 2005. This work is discussed in detail in Section 3.3, “Tank S-102 Retrieval Monitoring.”

Although retrieval operations were underway at two tanks in S Farm during the quarter, no RAS monitoring operations were conducted. This is because operators required for the RAS are routinely assigned to other work.

2.8 SX Tank Farm

Routine monitoring was not performed in SX Tank Farm during the 2nd quarter of FY 2005. To date, 69 of 100 (69%) boreholes in SX Farm have been monitored at least once since the baseline was complete. The date of the last routine monitoring event in SX Farm was 8/12/03.

2.9 T Tank Farm

Routine monitoring was not performed in T Tank Farm during the 2nd quarter of FY 2005. To date, 40 of 69 (58%) boreholes in T Farm have been monitored at least once since the baseline was complete. The date of the last routine monitoring event in T Farm was 6/18/03.

2.10 TX Tank Farm

Routine monitoring was not performed in TX Tank Farm during the 2nd quarter of FY 2005. To date, 29 of 94 (31%) boreholes in TX Farm have been monitored at least once since the baseline was complete. The date of the last routine monitoring event in TX Farm was 6/4/03.

2.11 TY Tank Farm

Routine monitoring was not performed in TY Tank Farm during the 2nd quarter of FY 2005. To date, 13 of 22 (59%) boreholes in TY Farm have been monitored at least once since the baseline was complete. The date of the last routine monitoring event in TY Farm was 5/29/03.

2.12 U Tank Farm

Routine monitoring was not performed in U Tank Farm during the 2nd quarter of FY 2005. To date, 34 of 59 (58%) boreholes in U Farm have been monitored at least once since the baseline was complete. The date of the last routine monitoring event in U Farm was 8/20/03.

3.0 Retrieval Monitoring

3.1 Tank C-106 Retrieval Monitoring

The *Process Control Plan for Tank 241-C-106 Acid Dissolution* (Reynolds 2003) specified retrieval monitoring was to be conducted monthly: “*The wells will be monitored monthly (or before initial acid addition, monthly during retrieval, and after retrieval) to detect any changes in the radiation or moisture profiles of the soil.*” Additional manual measurements are to be performed by operations personnel within specific zones at a frequency of two times per week.

RAS retrieval monitoring started in January 2003, and seven retrieval monitoring events were conducted by the end of FY 2004. A retrieval monitoring event is described as a complete set of logs around a tank acquired at approximately the same time. Beginning in April 2003, seven NMLS log events were acquired through the end of the 1st quarter of FY 2005. SGLS logging was performed in boreholes 30-06-02, -04, -09, -10, and 30-08-02 during late February and early March 2004 to investigate regions of apparent moisture increases. This logging was performed as a result of the PER initiated on December 3, 2003, in response to the apparent increase in moisture (~1%) in the vadose zone beneath tank C-106. The only increases in gamma activity identified during this logging occurred in boreholes 30-08-02 and 30-06-10. This zone of contaminant movement had been identified before the start of retrieval activities and therefore is not necessarily related to the retrieval process. Appendix B includes a summary plot of data acquired around tank C-106. These data include SGLS baseline measurements (⁴⁰K, ¹³⁷Cs, ⁶⁰Co), seven moisture measurements, and the RAS measurements acquired through the end of the 2nd quarter of FY 2005.

The final post-retrieval moisture logging event was conducted during the 1st quarter of FY 2005. No significant moisture changes were observed during the final logging event. The post-retrieval RAS monitoring was completed in four of the eight boreholes during the 2nd quarter of FY 2005. The remaining four boreholes will be monitored as soon as CH2M HILL can provide resources to operate the system. Stoller will issue a final C-106 retrieval monitoring report after the post-retrieval round of RAS monitoring has been completed. As of March 31, 2005, this work is delayed indefinitely pending available operator support.

3.2 Tank S-112 Retrieval Monitoring

The *Process Control Plan for Saltcake Dissolution Retrieval Demonstration in Tank 241-S-112* (Barton 2003) specified retrieval monitoring requirements. “*A baseline profile will be taken prior to retrieval operations, and subsequent monitoring results will be compared with that baseline profile. Moisture monitoring using the truck-mounted system will be done before beginning, at the end, and whenever there is a shutdown of retrieval operations greater than 4 weeks. An initial baseline will be established by deploying calibrated gamma and neutron moisture probes over the full depth of each drywell. During waste retrieval operations, the truck-mounted systems will be supplemented by the use of manually deployed moisture gages at least once a week while actively retrieving the waste at depths corresponding to moist layers at or below the floor of the tank.*”

The baseline moisture measurements were acquired during August 2003. Three additional moisture logging events (October, November, and February) were performed in the eight boreholes surrounding tank S-112. A fourth moisture logging event was started in boreholes 40-11-08 and 40-12-04 in April 2004. This logging event was cut short by the fresh-air entry requirement and was not completed. Moisture logging resumed during the 1st quarter of FY 2005 and all the S-112 boreholes were logged once during this quarter with the NMLS. There were minor increases identified during the latest moisture logging events, but these may be attributable to seasonal fluctuations. Additional moisture logging events will help assess the effects of seasonal moisture variations. The last RAS measurements were acquired during February 2004. Additional RAS measurements will be made as soon as CH2M HILL provides resources to operate the RAS. No changes in activity are observed between the two RAS measurements collected in November 2003 and February 2004 or since the baseline spectral gamma data acquired in 1996. As of March 31, 2005, this work is delayed indefinitely pending available operator support.

Log plots showing the baseline SGLS data, RAS data, and moisture data for each borehole are included in Appendix C.

3.3 Tank S-102 Retrieval Monitoring

In anticipation of future tank S-102 retrieval activities, RAS monitoring of the boreholes around tank S-102 began in September 2002. The first RAS retrieval monitoring event was performed in July 2003. The RAS collected monitoring data from five of the nine boreholes (event 2) in April 2004. The other four boreholes were not monitored because work was halted due to the fresh-air entry requirement imposed on approximately April 16, 2004. An increase in ¹³⁷Cs concentration was discovered in borehole 40-02-03 between 44 and 47 ft during the first RAS monitoring event in July 2003. This increase was first reported in the *Annual Monitoring Report for Fiscal Year 2003* (DOE 2004).

Baseline moisture logging was performed in eight of the nine boreholes surrounding this tank in April 2004. Moisture logging was not performed in borehole 40-02-04 because surface equipment prevented access to this borehole. SGLS logging was performed over selected intervals from three of these boreholes (40-02-03, 40-02-07, and 40-02-08) to update the baseline in areas of known vadose zone contamination. The SGLS logging confirmed the ¹³⁷Cs increase in borehole 40-02-03. High rate logging was also performed in borehole 40-02-03. Log plots of the data collected above were provided to CH2M HILL via e-mail on April 12, 2004. These log plots are included in Appendix E.

No RAS monitoring has been performed since April of 2004. The increase in ¹³⁷Cs relative to the baseline in borehole 40-02-03 occurred prior to the beginning of retrieval operations, but there is no data in the past year to determine what effect, if any, retrieval operations have had on this plume. RAS monitoring for the S-102 Retrieval Project will resume as soon as CH2M HILL provides resources to operate the system. As of March 31, 2005, this work is delayed indefinitely, pending available operator support.

The second event of moisture logging was initiated for the S-102 Retrieval Project during the 1st quarter of FY 2005. Moisture logging was completed during the 2nd quarter of FY 2005. No significant changes to the baseline moisture profiles were observed. Log plots of all the available RAS and moisture data are provided in Appendix D.

3.4 S-109 Retrieval Monitoring

CH2M HILL has contacted Stoller regarding the planned start of the Phase 1 of S-109 Partial Retrieval Project in October 2005 and the associated monitoring. Borehole monitoring must be performed no more than 2 months prior to the start of the retrieval activities, approximately August 22, 2005. Stoller and CH2M HILL agreed it would be best to collect the pre-retrieval baseline measurements with the new Retrieval Monitoring System (RMS) that Stoller is currently building. Stoller hopes to have the system operational in time to support this effort, but the NMLS and RAS system may be used in its place if this deadline cannot be met. Eight boreholes were selected for S-109 retrieval monitoring: 40-08-09, 40-09-05, 40-09-06, 40-09-08, 40-09-09, 40-06-06, 40-09-01, and 40-09-02.

3.5 Tank C-103 Retrieval Monitoring

The waste retrieval for tank C-103 was scheduled to begin in early calendar year (CY) 2005. Baseline moisture logging and pre-retrieval RAS monitoring have yet to be performed in the boreholes surrounding this tank. Six boreholes were selected for C-103 retrieval monitoring: 30-03-01, 30-03-03, 30-03-05, 30-03-07, 30-03-09, and 30-06-04. These activities will commence as resources and construction activities around tank C-103 allow.

4.0 Special Projects

4.1 Tank AX-103 Leak Assessment

A liquid observation well (LOW) scan in tank AX-103 recorded a liquid level drop of 2.7 inches on 12/12/04. The decrease in liquid level was confirmed with an additional scan on 12/16/04. PER-2004-6221 was initiated on 12/20/04 by CH2M HILL to address the issue. At the end of December 2004, a tank leak assessment was initiated; Stoller was asked to provide existing RAS data from tank AX-103 and to monitor all the drywells surrounding tank AX-103. The seven boreholes surrounding tank AX-103 (11-01-09, 11-03-02, 11-03-05, 11-03-07, 11-03-09, 11-03-10, and 11-03-12) were all monitored during the 2nd quarter of FY 2005. There were no indications of increased gamma activity in any of the data collected from these boreholes. The *AX-103 Drywell Investigation Summary Report* (DOE 2005) was sent to Mr. Nick W. Kirch at CH2M HILL on March 28, 2005. A copy of this report is included as Appendix E.

4.2 S-102 Fluid Injection Test

CH2M HILL intends to perform a fluid injection test in one of the boreholes on the west side of tank S-102. This will be used to test the High Resolution Resistivity Leak Detection and Monitoring System (HRR-LDMS) installed around tank S-102. Stoller was contacted by CH2M HILL regarding the deployment of the RAS to monitor boreholes near the borehole in which the fluid would be injected. This test will be conducted simultaneously with the tank S-102 retrieval activities, where by the RAS data will be used to distinguish possible leaks from the tank from moisture increases associated with the test; NMLS measurements were not requested.

5.0 Operational Issues

Eleven boreholes were monitored with the RAS during the 2nd quarter of FY 2005. The original project goal was to monitor an average of three boreholes per day. This goal has been reduced to approximately 1 borehole per day due to the new respiratory requirements imposed on Tank Farm personnel. The monitoring rate achieved this quarter was 0.2 boreholes per day.

Operators were only made available on 12 of the 56 days during the 2nd quarter of FY 2005 to operate the RAS. The RAS project has often had lower priority than other tank farm projects when manpower resources are assigned; therefore, RAS operators are diverted to these other tasks.

Tables 5-1 and 5-2 include summaries of production and operational issues, respectively, that affect monitoring production.

Table 5-1. Summary of Monitoring Production (Project-to-Date)

Quarter	Total Work Days	Total Days Down	Total Monitoring Events	Boreholes Monitored per Day
4 th of FY01	56	29.3	84	1.5
1 st of FY02	56	35.2	54	1.0
2 nd of FY02	55	34.1	74	1.3
3 rd of FY02	59	21.1	113	1.9
4 th of FY02	66	27.6	144	2.2
1 st of FY03	56	34.7	72	1.3
2 nd of FY03	55	22.5	97	1.8
3 rd of FY03	58	25.0	105	1.8
4 th of FY03	63	22.6	103	1.6
1 st of FY04	56	27.4	56	1.0
2 nd of FY04	55	42.1	24	0.4
3 rd of FY04	63	59.9	5	0.1
4 th of FY04	62	62.0	0	0.0
1 st of FY05	55	55.0	0	0.0
2 nd of FY05 (current)	56	47.7	11	0.2
Cumulative Total	871	546.2	942	1.1
Average/Quarter	58.1	36.4	62.8	1.1

Table 5-2. Summary of Operational Down Time

Quarter	Equipment/ Truck Problems/Calibration (hrs)	No HPT/ Operator Support (hrs)	Security Measures (hrs)	No Charge Code or Administrative (hrs)	Moving Truck (hrs)	Weather (hrs)	Misc. / Fresh Air Requirement (hrs)	Total Down Time (hrs)
4 th of FY01	64	130	20	27	20	3	0	264
1 st of FY02	107	84	51	44	14	13	4	317
2 nd of FY02	143	40	24	58	9	18	15	307
3 rd of FY02	31	62	0	36	27	8	26	190
4 th of FY02	81	122	0	0	37	0	8	248
1 st of FY03	71	107	0	18	18	0	98	312
2 nd of FY03	62	126	0	0	10	0	0	198
3 rd of FY03	51	149	0	0	12	0	13	225
4 th of FY03	45	136	0	0	16	6	0	203
1 st of FY04	6	198	0	0	12	22	9	247
2 nd of FY04	178	95	0	0	6	98	2	379
3 rd of FY04	26	18	0	9	2	0	424	479
4 th of FY04	0	0	0	0	0	0	513	513
1 st of FY05	0	490	0	0	0	0	0	490
2 nd of FY05 (current)	0	398	0	18	0	13	0	429
Cumulative Total	865	2155	95	210	183	181	1112	4801
Average/Quarter	57.7	143.7	6.3	14.0	12.2	12.1	74.1	320.1

6.0 Summary

A total of 857 routine monitoring logs (114 retrieval logs) have been collected since the beginning of the project in June 2001. An additional 111 logs (7 logs during the 2nd quarter of FY 2005) using the NMLS were provided. To date, most of the high priority boreholes in all tank farms have been monitored at least once, but the recommended monitoring frequency has not been met for these boreholes. There are 306 lower priority boreholes within the single-shell tank farms that have not been monitored at all in the past five to ten years.

Evidence of possible contaminant movement has been detected in 29 boreholes in nine tank farms. Of these 29 boreholes, data collected from three boreholes (30-06-10, 30-08-02, and 40-02-03) indicate movement to a degree that can be confirmed over a short time interval. Of the remaining 26 boreholes, it is likely that the elapsed time between monitoring events is not sufficient to detect subtle changes in contaminant profile, suggesting relatively slow movement of contaminants in the vadose zone. In general, intervals where discernable movement of contaminants through the vadose zone is occurring within short periods of time (i.e., less than

1.5 years) appear to be very limited. However, since monitoring has been severely curtailed for 1.5 years, this observation is speculative. This finding, if corroborated by continued measurements, will be useful to select appropriate remedial actions for tank farm closure and/or removal of contaminated soil. However, it should be noted that many boreholes with extremely high radiation levels have not been monitored at all since the baseline was completed.

7.0 Future Monitoring Operations

Due to regulatory commitments and operating limitations in tank farms, DOE-ORP and their contractor have re-focused the monitoring effort from routine monitoring to retrieval monitoring. Therefore, the monitoring schedule for the RAS will be added onto the monitoring requirements associated with the various retrieval projects. This schedule will also apply to the NMLS logging required for the retrieval projects. Appendix F provides a summary of boreholes scheduled for retrieval monitoring through the end of the 3rd quarter of FY 2005. Due to the respiratory requirements placed on personnel entering the tank farms it is unlikely this schedule will be met.

A new, portable logging system capable of recording gross gamma and moisture measurements simultaneously was received during the 2nd quarter of FY 2005. This system, designated as the Retrieval Monitoring System (RMS), has been mounted in a utility vehicle provided by CH2M HILL and is ready for preliminary testing. The Operational Test Plan for the RMS is included as Appendix G. Stoller is waiting for a Type A, 7A container to be manufactured so the neutron source can be transported across the Hanford Site. Once this container arrives, Stoller will begin testing and calibration of the RMS. Stoller anticipates having this system ready to begin monitoring in support of the retrieval projects during the 4th quarter of FY 2005. The RMS will replace the RAS and NMLS and will be operated by the Hanford Atomic Metal Trades Council (HAMTC) operators. It is planned that the RAS be left intact for future routine monitoring.

8.0 Recommendations

The monitoring program in the single-shell tank farms was initiated in 2000 after the initial success of the Vadose Zone Characterization Project. Experience gained from the past baseline characterization efforts and current activities during this period suggest significant changes in the monitoring of tank farms. Based upon this experience, significant issues and recommendations for improvement are discussed below.

8.1 Routine Monitoring Program

Vadose zone monitoring activities in the single-shell tank farms are performed according to guidance from the ORP tank farm contractor with supervision and technical input from Stoller. In the past year, there has been effectively no routine monitoring in the single-shell tank farms.

Routine monitoring operations are dependent upon personnel employed by the tank farms contractor, whose primary goal is waste retrieval.

The primary reasons routine monitoring activities have been discontinued are the prioritization of resources and personnel to retrieval operations and tank farm access restrictions arising from health and safety concerns. It is strongly recommended that routine monitoring activities be re-emphasized. This will require that the monitoring activity be given a higher priority for resource allocation at tank farms. At a minimum the 29 boreholes that have exhibited contaminant movement in the past should be logged during the next quarter.

Comparison of ongoing monitoring data with baseline and historical data is important in unraveling the complex leak history in the single-shell tank farms, assessing stability of individual contaminant plumes, and determining the suitability of individual tanks for sluicing operations. In the vicinity of tank C-106, for example, routine monitoring data has detected continued downward movement in a ^{60}Co plume on the north side of the tank. Baseline data indicate that the plume likely originated between tanks C-108 and C-109. It appears to be moving downward and to the east in the region between tanks C-109 and C-106. Routine monitoring activities detected this movement well before retrieval operations were initiated in tank C-106, and thus established that the observed increases in subsurface activity were not related to tank C-106 retrieval operations. In the absence of a routine monitoring program, it is possible that observed changes in this plume would have been attributed to the retrieval operation, resulting in an erroneous determination that a leak had occurred. Clearly defined and uniformly implemented requirements for routine and tank-retrieval leak detection monitoring will improve credibility and the potential acceptability of future Hanford remedial actions, including closure of tank farms.

8.2 Centralize Responsibility for Geophysical Monitoring Technology, Equipment, and Data Interpretation

New, low-cost portable logging systems can be used for the monthly monitoring events now performed by the RAS and SGLS. They can also be used for more frequent measurements, replacing the existing manual moisture monitoring units. This improves overall data comparability and reduces the potential for false detections based on increase in observed moisture. Under the current monitoring approach, any increase in moisture observed with the manual moisture gauges results in an immediate need for gamma logging to determine if a leak has in fact occurred. In addition, manual moisture monitoring is subject to data transcription errors and to errors associated with slight variations in depth between successive measurements. In many cases, a specific monitoring point is selected at a peak in the neutron moisture log. When subsequent manual moisture measurements are made, slight variations in detector depth may appear as changes in moisture content. The portable logging equipment will provide combined and continuous neutron moisture and gamma activity measurements over a specified depth interval with electronic data recording. This eliminates the potential for transcription errors and provides a continuous profile, which allows depth errors to be more readily recognized. In addition, new technologies such as High Resolution Resistivity (HRR) are being

investigated without benefit of baseline comparison plans or integration into the ongoing monitoring or retrieval monitoring programs.

At present, RAS and NMLS data are processed and evaluated by Stoller, while the manual moisture measurements are reported to CH2M HILL. This creates a situation wherein discrepancies between the two data sets may not be immediately recognized.

Recently CH2M HILL has reported that gamma activity measurements are being made in laterals underneath tanks in AX and SX Tank Farms. This work is being done with no input or consultation from Stoller, and it is not clear how (or if) the results of this work can be compared to the tank farms baseline. Moreover, CH2M HILL continues to use handheld moisture units that have not been calibrated in over two years. While CH2M HILL reports that successive measurements show consistent results, with no indication of increases, only limited intervals are being monitored, and the long-term stability of the detectors is in doubt. Geophysical methods such as HRR offer some advantages over borehole logging, but the HRR program is being implemented with no effort to integrate it into the existing data framework. For the immediate future, it is likely that any anomaly detected by the HRR will require some degree of investigation by borehole logging, particularly since HRR only responds to variations in subsurface moisture content, which is not by itself an unequivocal indication of a tank leak. The general lack of communication and coordination, and continual reassignment of monitoring resources to other projects has resulted in a total inability to detect new tank leaks or continuing contaminant migration. Because the retrieval program has effectively directed all resources away from routine monitoring, vadose zone conditions around most of the tanks are not being monitored since completion of the baseline in 2000, and any leaks or continuing migration that might impact groundwater are simply unknown.

The designation of a single contractor responsible for geophysical logging to collect, evaluate, and manage borehole and vadose zone monitoring technological needs, equipment, and measurement data would significantly improve the effectiveness and quality of Hanford geophysical data collection and interpretation.

8.3 Perform High Rate Logging

High rate logging has not been performed in the tank farms since FY 2002. Because the areas that exhibit high activity contain the greatest contaminant inventory in the farms, it is essential to monitor these areas for changes on a more frequent basis. Approximately 25 boreholes require high rate logging, which would require a level of effort of approximately 3 months.

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Barton, W.B., 2003. *Process Control Plan for Saltcake Dissolution Retrieval Demonstration in Tank 241-S-112*, RPP-15085, Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington.

Reynolds, D.A., 2003. *Process Control Plan for Tank 241-C-106 Acid Dissolution*, RPP-16462, Rev. 2, CH2M HILL Hanford Group, Inc., Richland, Washington.

U.S. Department of Energy (DOE), 2003. *Hanford Tank Farms Vadose Zone Monitoring Project, Baseline Monitoring Plan*, GJO-HGLP 1.8.1, Revision 0, Grand Junction Office, Grand Junction, Colorado.

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U.S. Department of Energy (DOE), 2005. *AX-103 Drywell Investigation Summary Report*, DOE-EM/GJ845-2005, Grand Junction Office, Grand Junction, Colorado.

Appendix A
Boreholes Monitored During 2nd Quarter of FY 2005

Table A-1. Routine Boreholes Monitored During the 2nd Quarter of FY 2005

Borehole Number	Tank	Top	Bottom	Footage	Rerun Footage	Log Freq. (days)	Next Log Date	Last Event Date	Total 2nd Qrt. Events	Total Events (to date)	Comment
11-01-09	AX-101	30	85	55	10	360	02/25/06	03/02/05	1	2	No apparent change
11-03-05	AX-103	35	85	50		1800	02/04/10	03/02/05	1	1	No apparent change
11-03-07	AX-103	30	85	55		1800	02/03/10	03/01/05	1	1	No apparent change
11-03-09	AX-103	30	85	55		1800	01/08/10	02/03/05	1	2	No apparent change
11-03-10	AX-103	30	85	55	10	1800	01/08/10	02/03/05	1	1	No apparent change
11-03-12	AX-103	30	85	55		1800	01/08/10	02/03/05	1	1	No apparent change
11-03-02	AX-103	20	90	70		360	01/12/06	01/17/05	1	3	No apparent change
	Total Footage=			395	20		Total Routine Events=			7	

Table A-2. Retrieval Boreholes Monitored During the 2nd Quarter of FY 2005

Borehole Number	Tank	Top	Bottom	Footage	Rerun Footage	Next Log Date	RAS Event A	RAS Event B	RAS Event C	RAS Event D	RAS Event E	RAS Event F	Ras Event G	Ras Event H	Ras Event I	Total 2nd Quarter Events	Total Events (to date)	Comment
30-06-09	C-106	5	98	93		04/13/05	04/22/02	01/22/03	04/22/03	07/22/03	09/10/03	10/23/03	12/12/03	02/19/04	03/08/05	1	9	No apparent change, C-106 Retrieval
30-06-03	C-106	0	98	98	10	04/05/05	01/23/03	04/28/03	07/21/03	09/16/03	10/22/03	12/02/03	02/23/04	02/28/05		1	8	No apparent change, C-106 Retrieval
30-06-02	C-106	0	121	121		03/30/05	01/27/03	04/28/03	07/21/03	09/16/03	10/21/03	01/26/04	02/23/04	02/22/05		1	8	No apparent change, C-106 Retrieval
30-00-01	C-106	0	65	65		03/22/05	04/24/02	01/16/03	04/28/03	07/22/03	09/15/03	11/03/03	12/02/03	03/01/04	02/14/05	1	9	No apparent change, C-106 Retrieval
	Total Footage=			377	10							Total Retrieval Events This Quarter=				4		

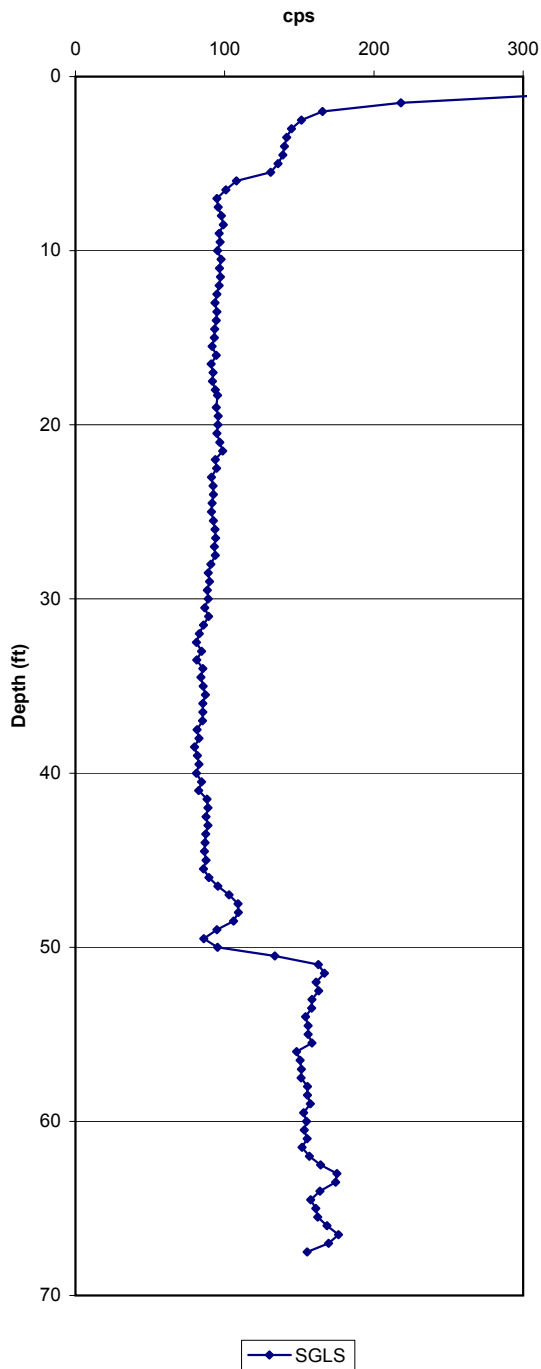
Table A-3. Retrieval Boreholes Logged with the Neutron Moisture Logging System During 2nd Quarter of FY 2005

Borehole Number	Tank	Top	Bottom	Footage	Rerun Footage	Next Event	NMLS Event 1	NMLS Event 2	Total 2nd Qrt FY05 Events	Total Events (to date)	Comment
40-02-01	S-102	0	128	128	10	02/11/05	04/08/04	01/12/05	1	2	No apparent change.
40-02-03	S-102	0	98	98	10	02/11/05	04/07/04	01/12/05	1	2	No apparent change.
40-02-05	S-102	0	97	97	10	02/17/05	03/25/04	01/18/05	1	2	No apparent change.
40-02-07	S-102	0	95	95	10	02/12/05	03/31/04	01/13/05	1	2	No apparent change.
40-02-08	S-102	0	100	100	10	02/02/05	04/06/04	01/03/05	1	2	No apparent change.
40-02-10	S-102	0	99	99	10	02/04/05	04/06/04	01/05/05	1	2	No apparent change.
40-02-11	S-102	0	100	100	10	02/10/05	03/25/04	01/11/05	1	2	No apparent change.
	Total Footage=			717	70		Total Events=		7		

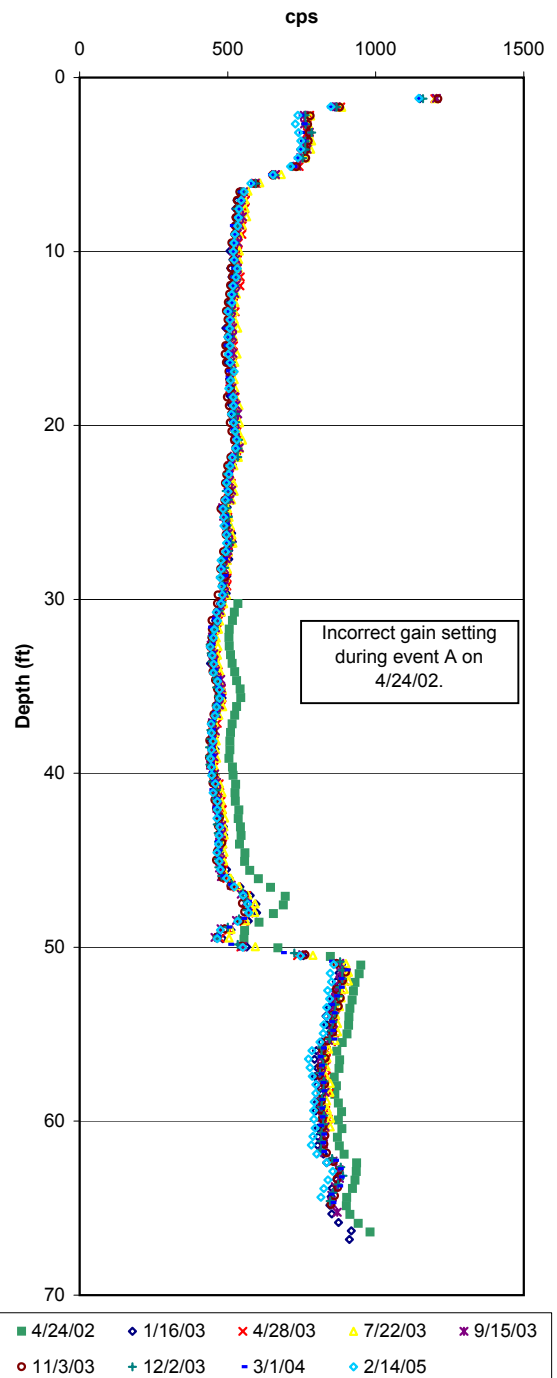
Appendix B
Tank C-106 Retrieval Monitoring Log Plots

Borehole 30-00-01

SGLS Total Gamma
Log Date: 4/14/97

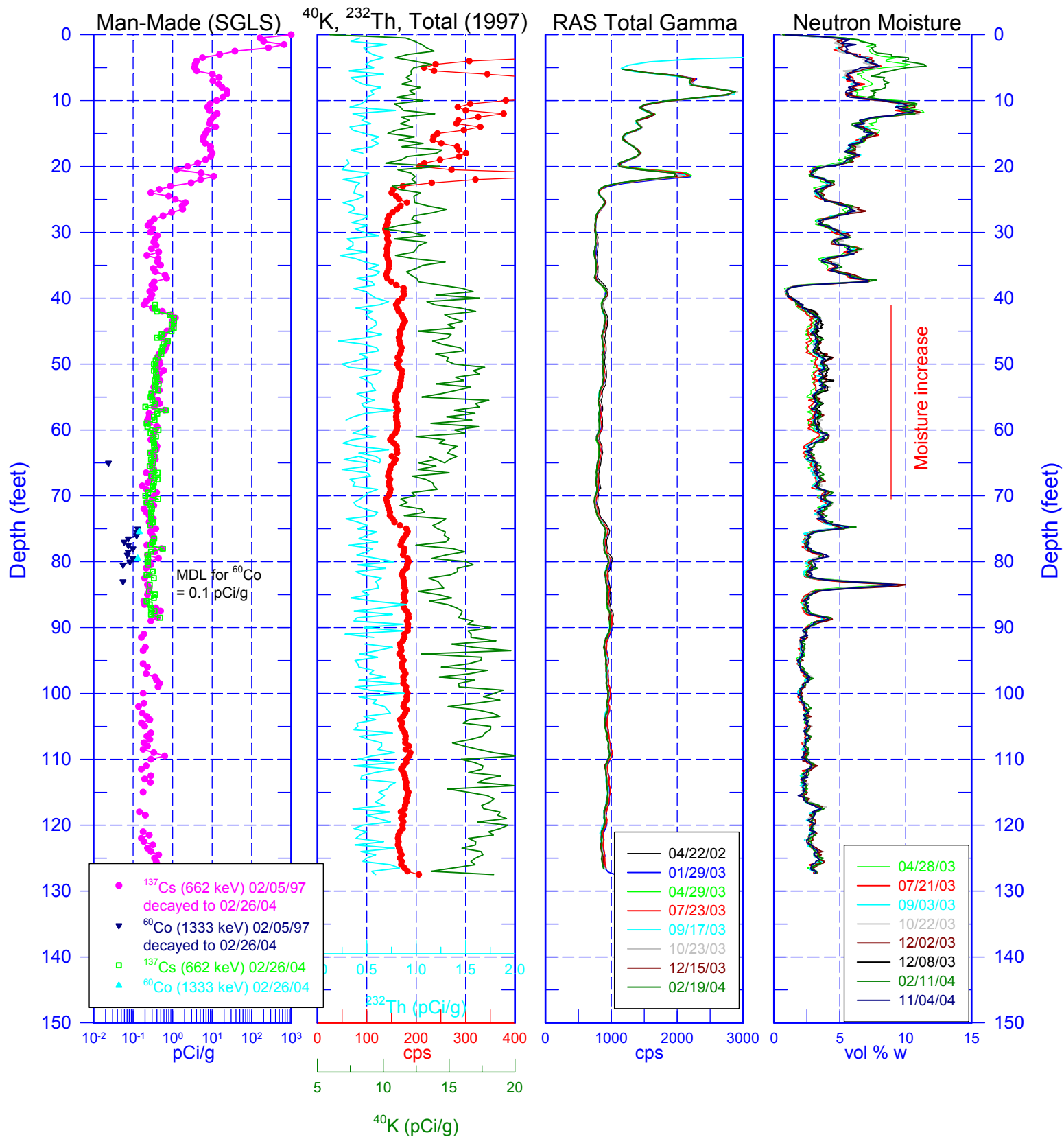


RAS Total Gamma (Large Detector)
Log Date: See Legend Below



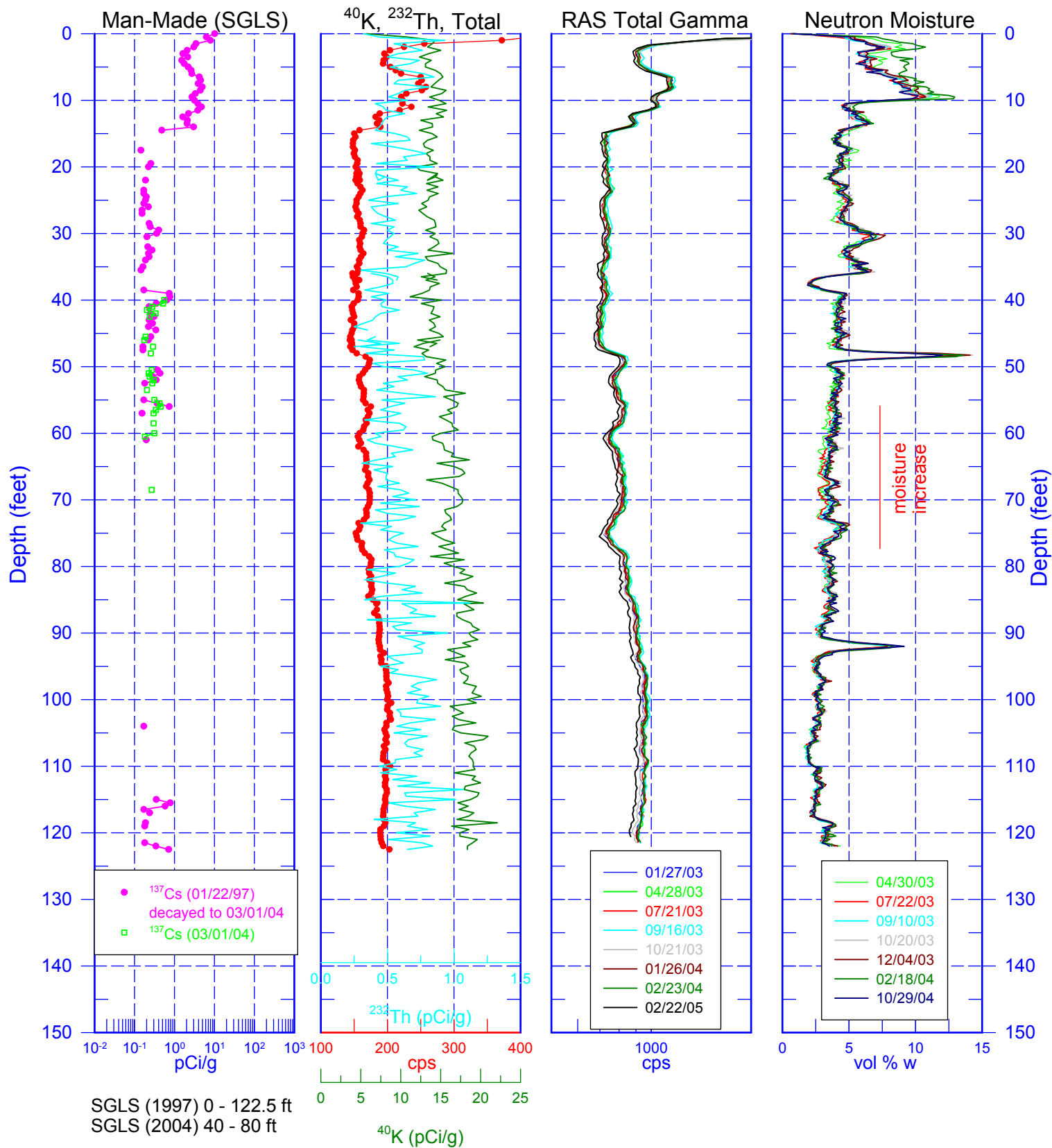
Tank C-105

30-05-02



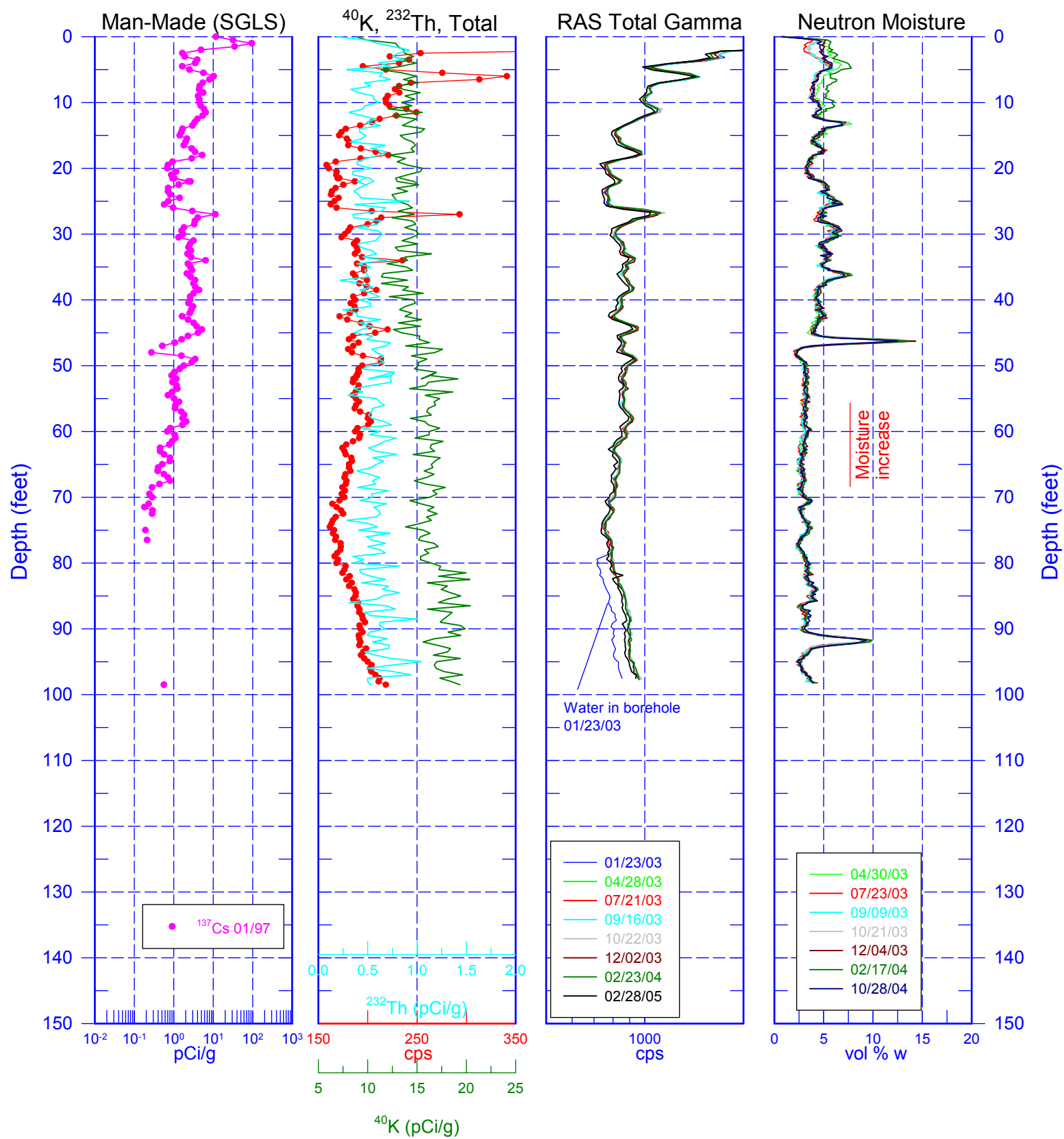
Tank C-106

30-06-02



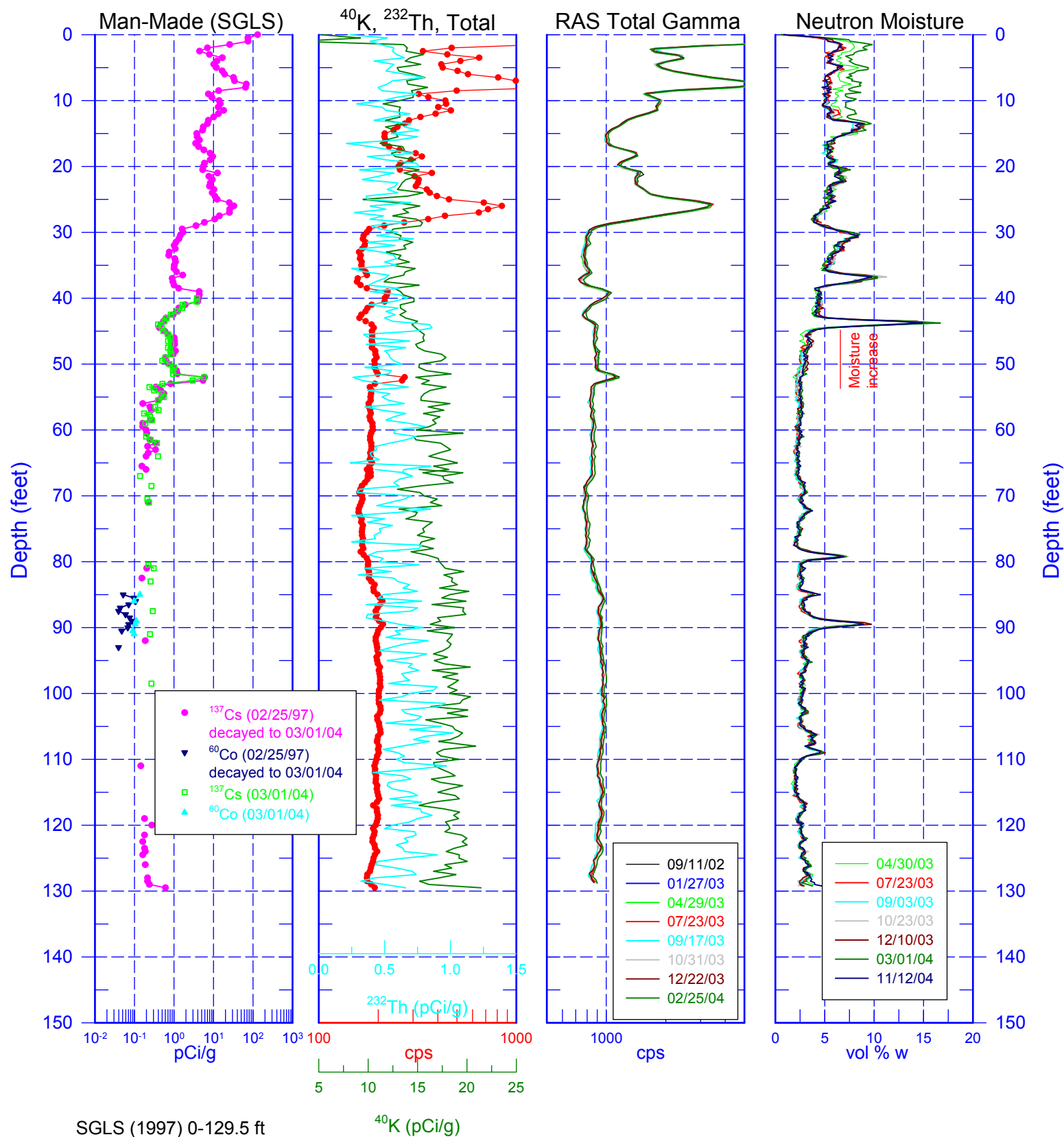
Tank C-106

30-06-03



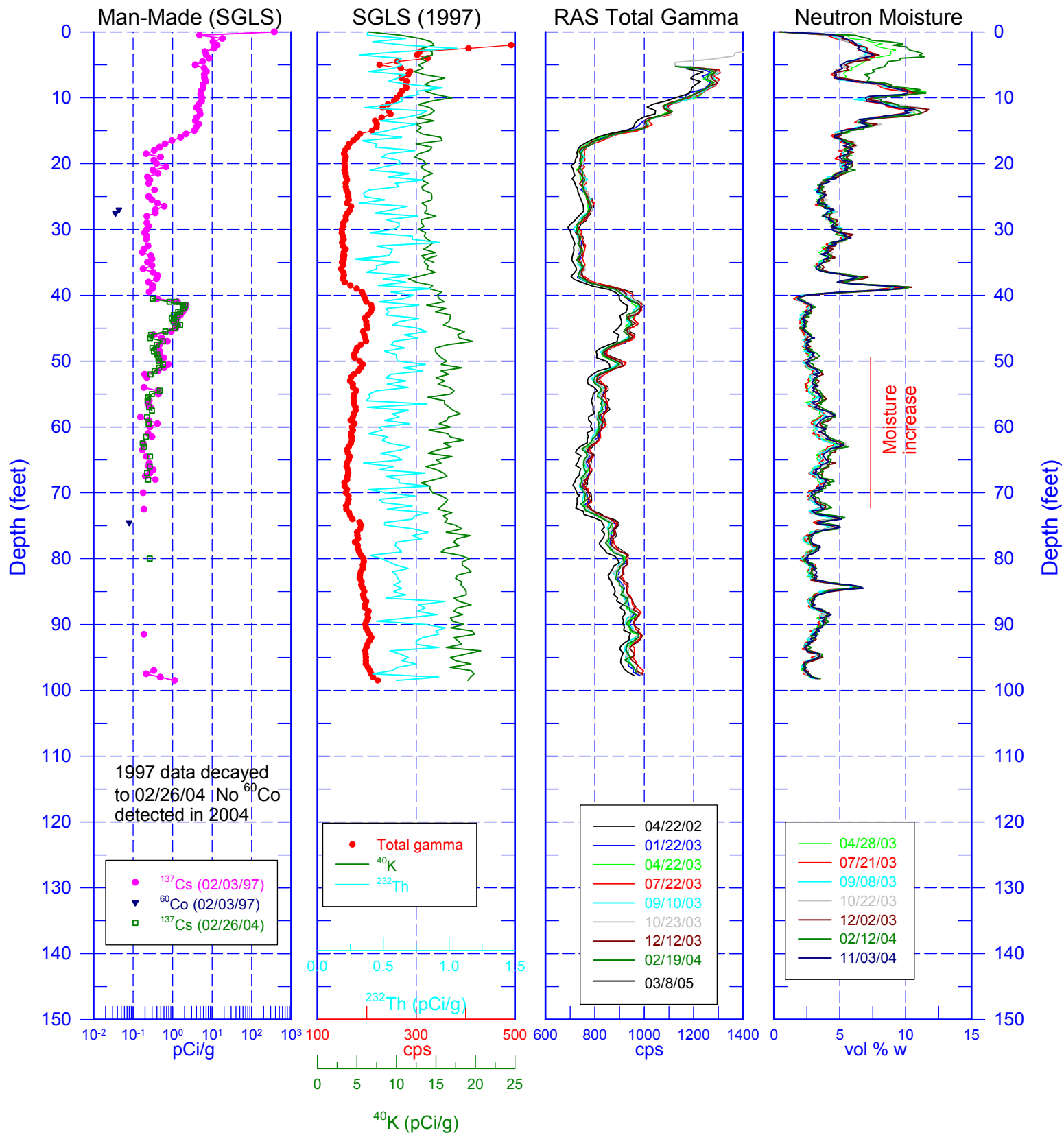
Tank C-106

30-06-04



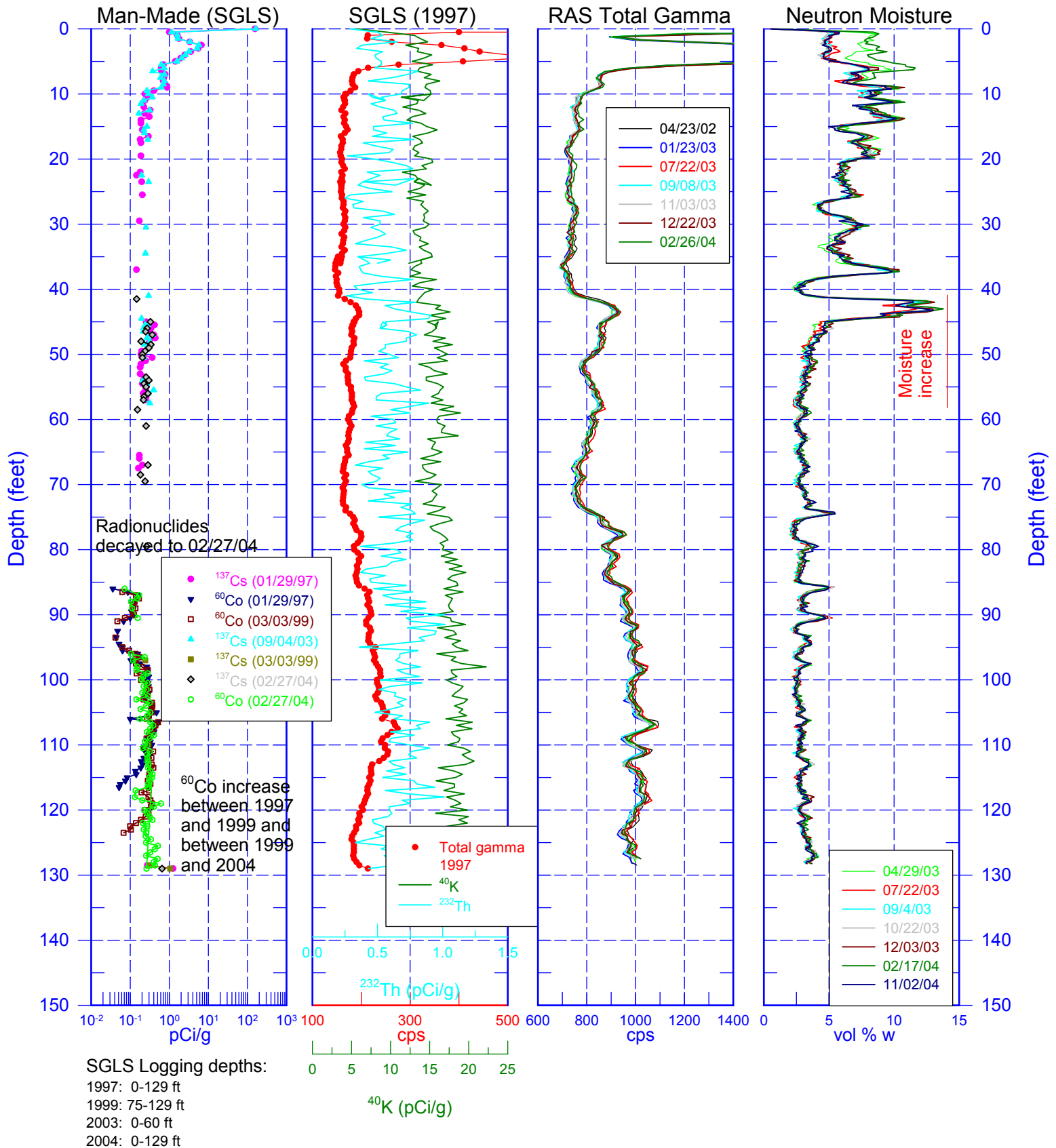
Tank C-106

30-06-09



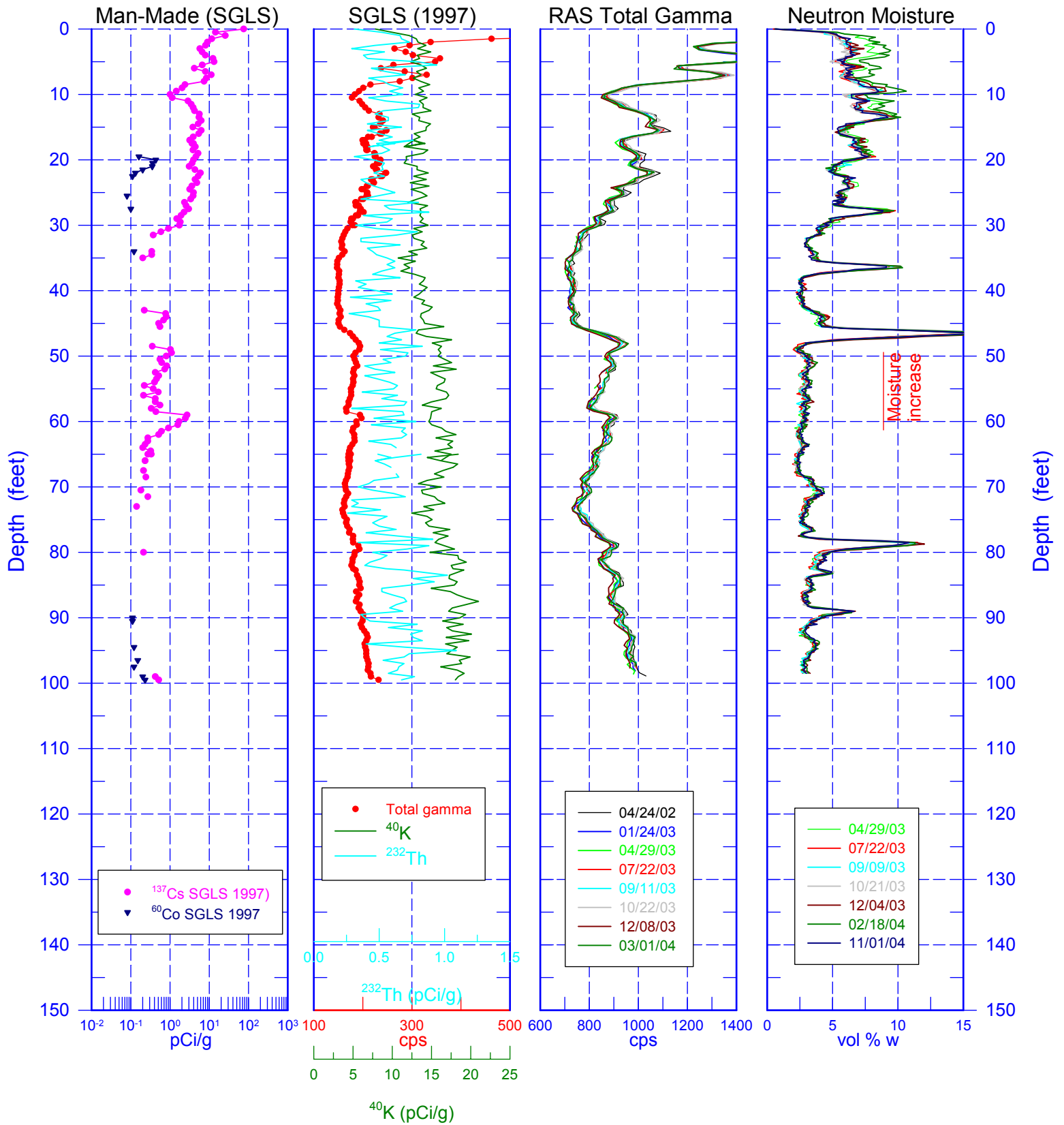
Tank C-106

30-06-10



Tank C-106

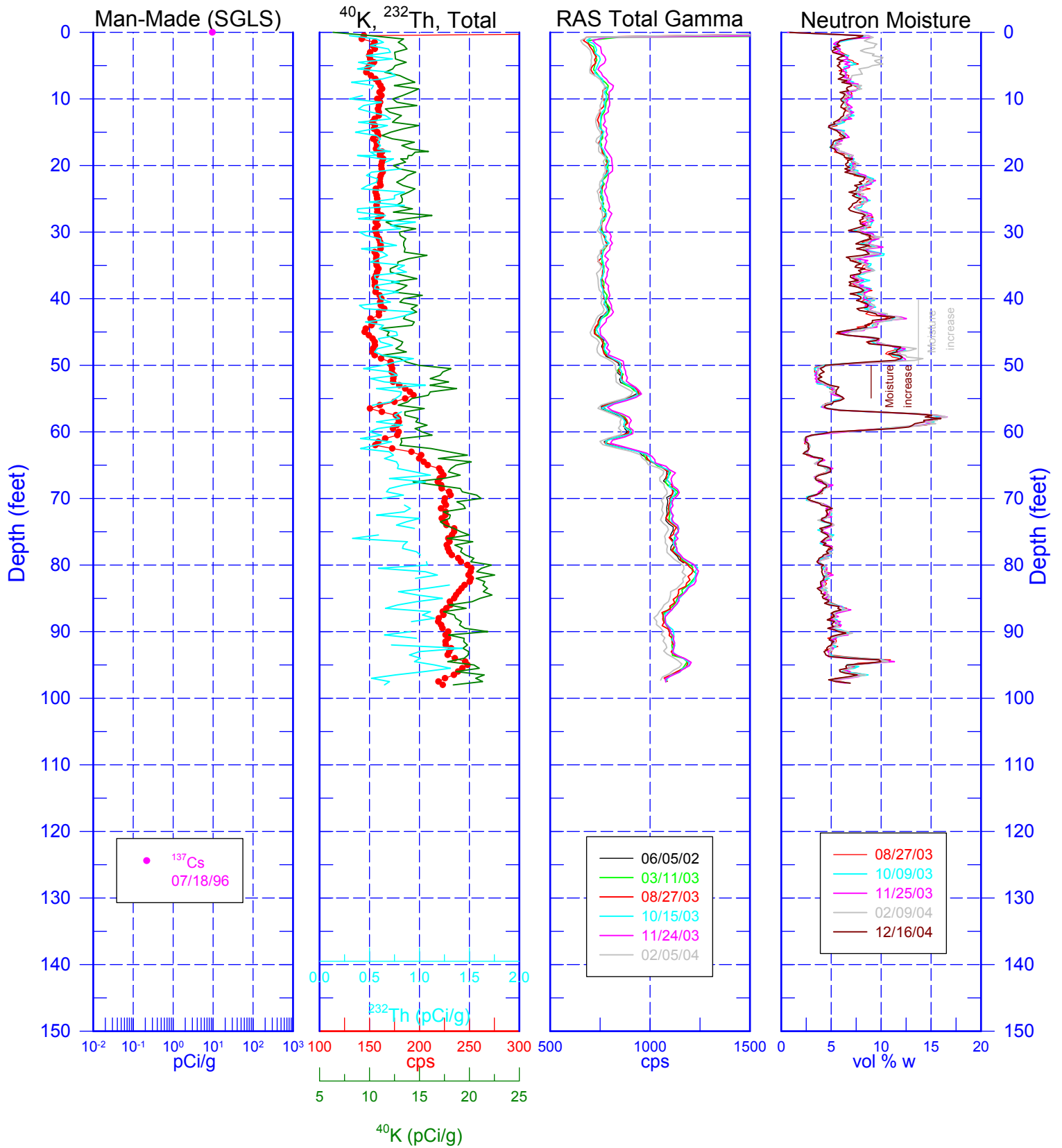
30-06-12



Appendix C
Tank S-112 Retrieval Monitoring Log Plots

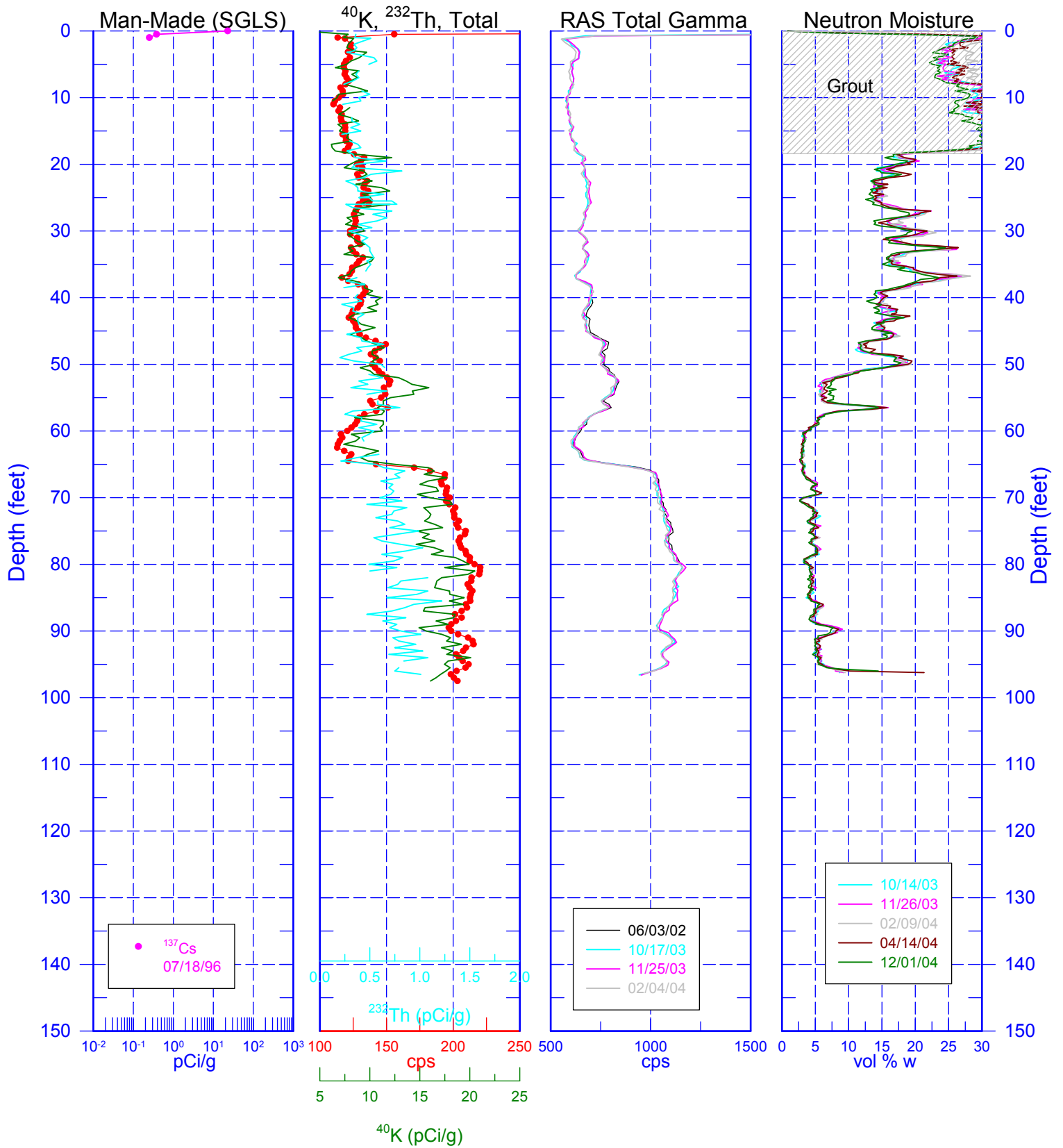
Tank S-109

40-09-06



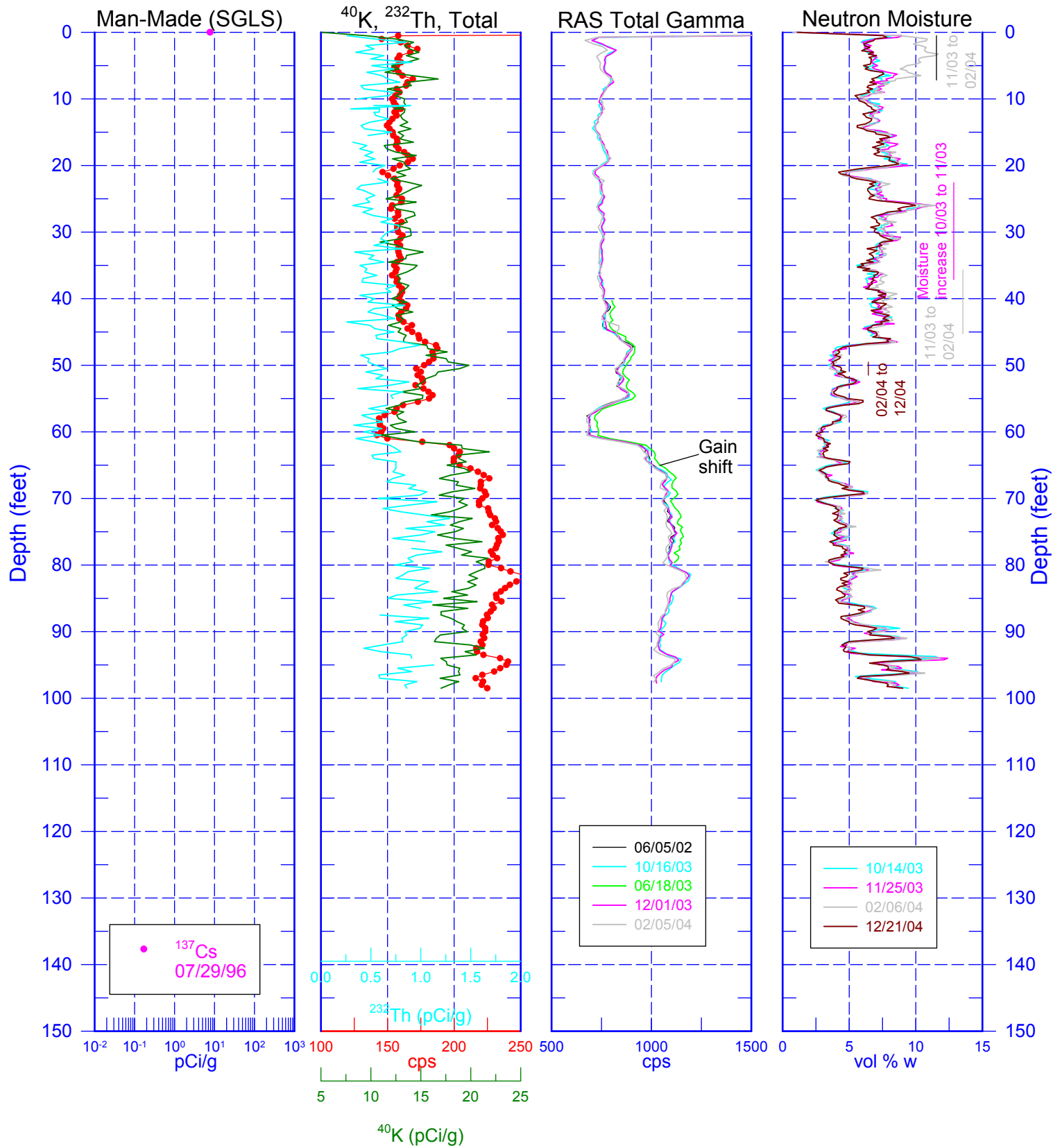
Tank S-111

40-11-08



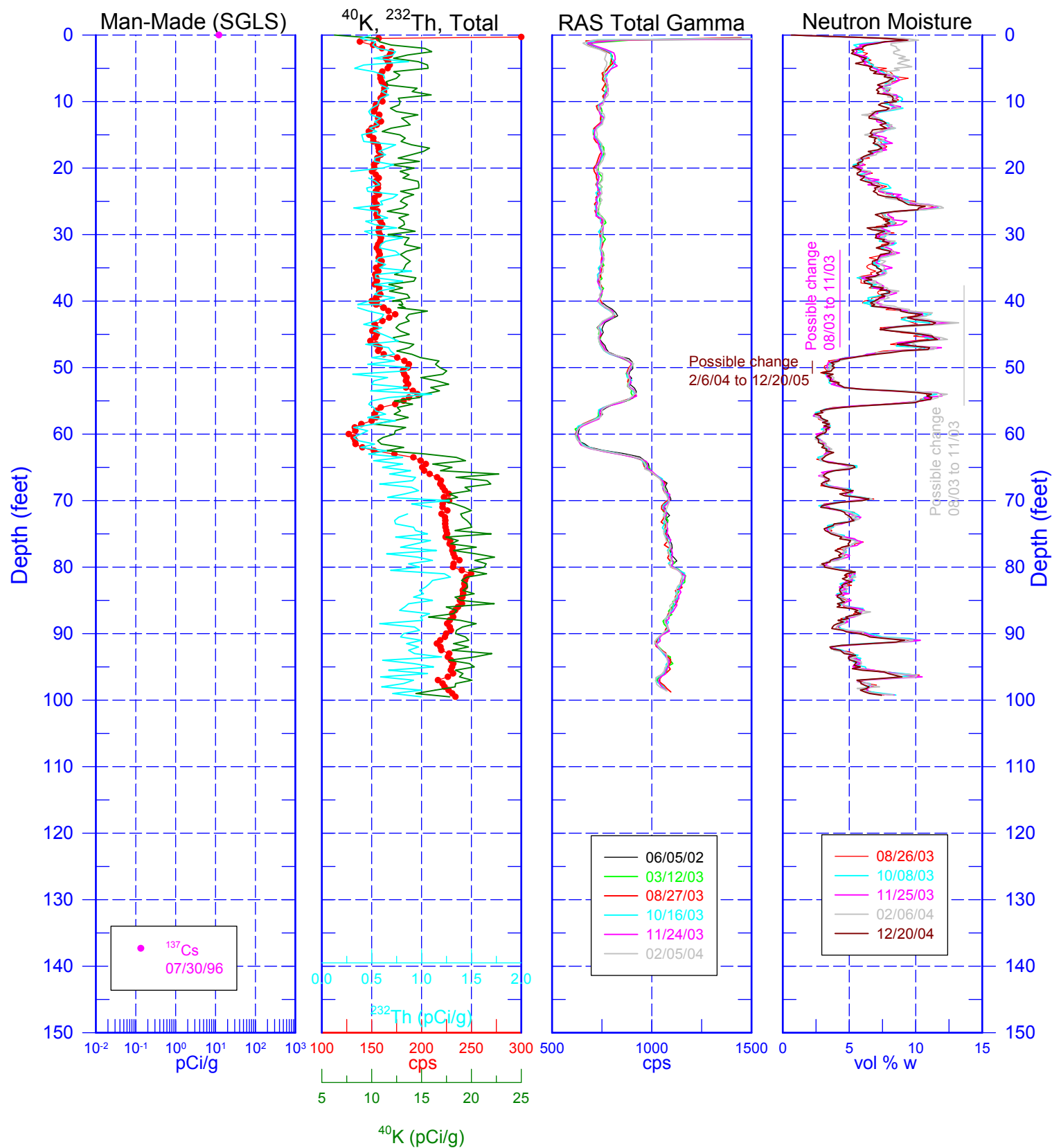
Tank S-111

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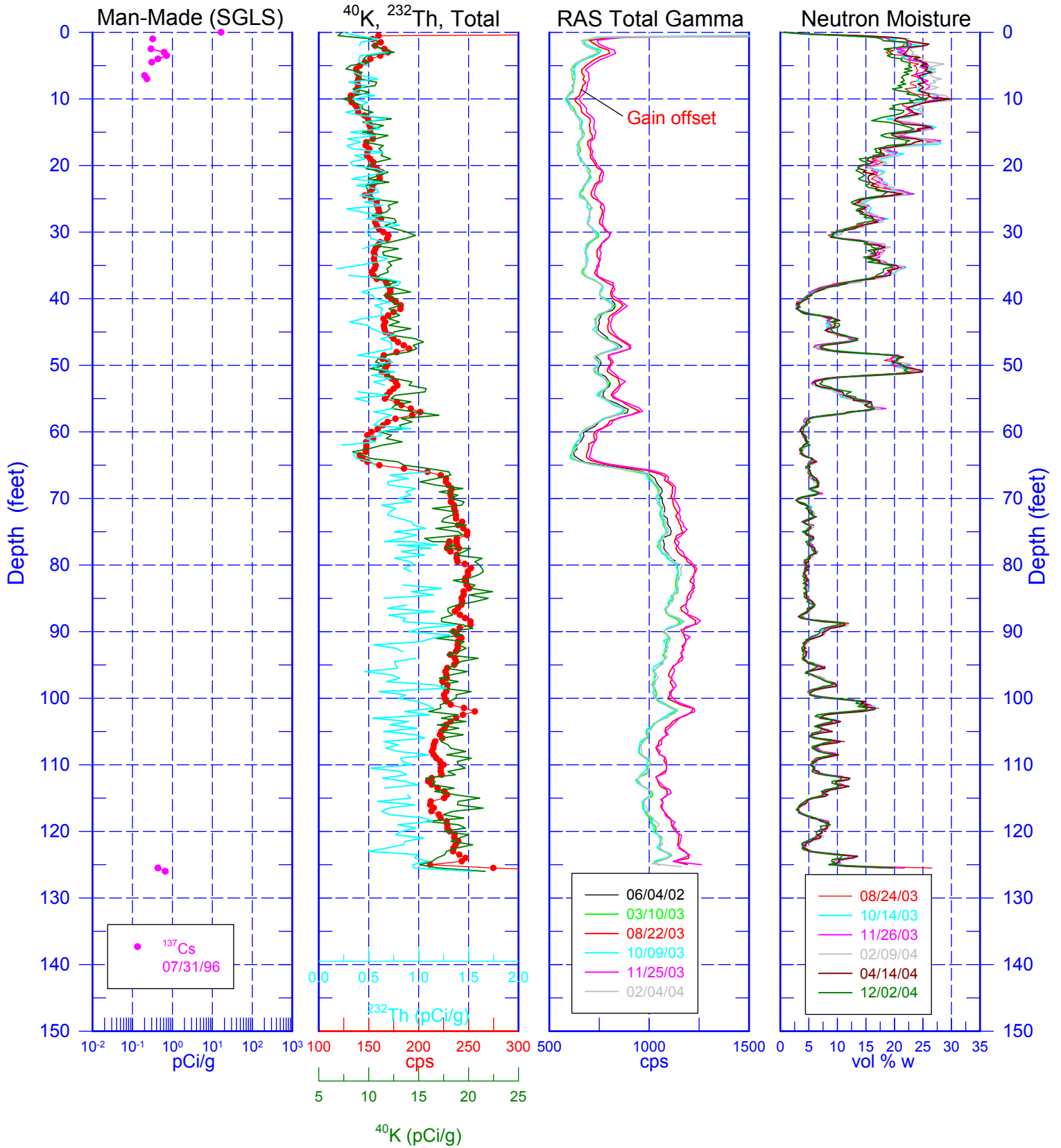
Tank S-112

40-12-02



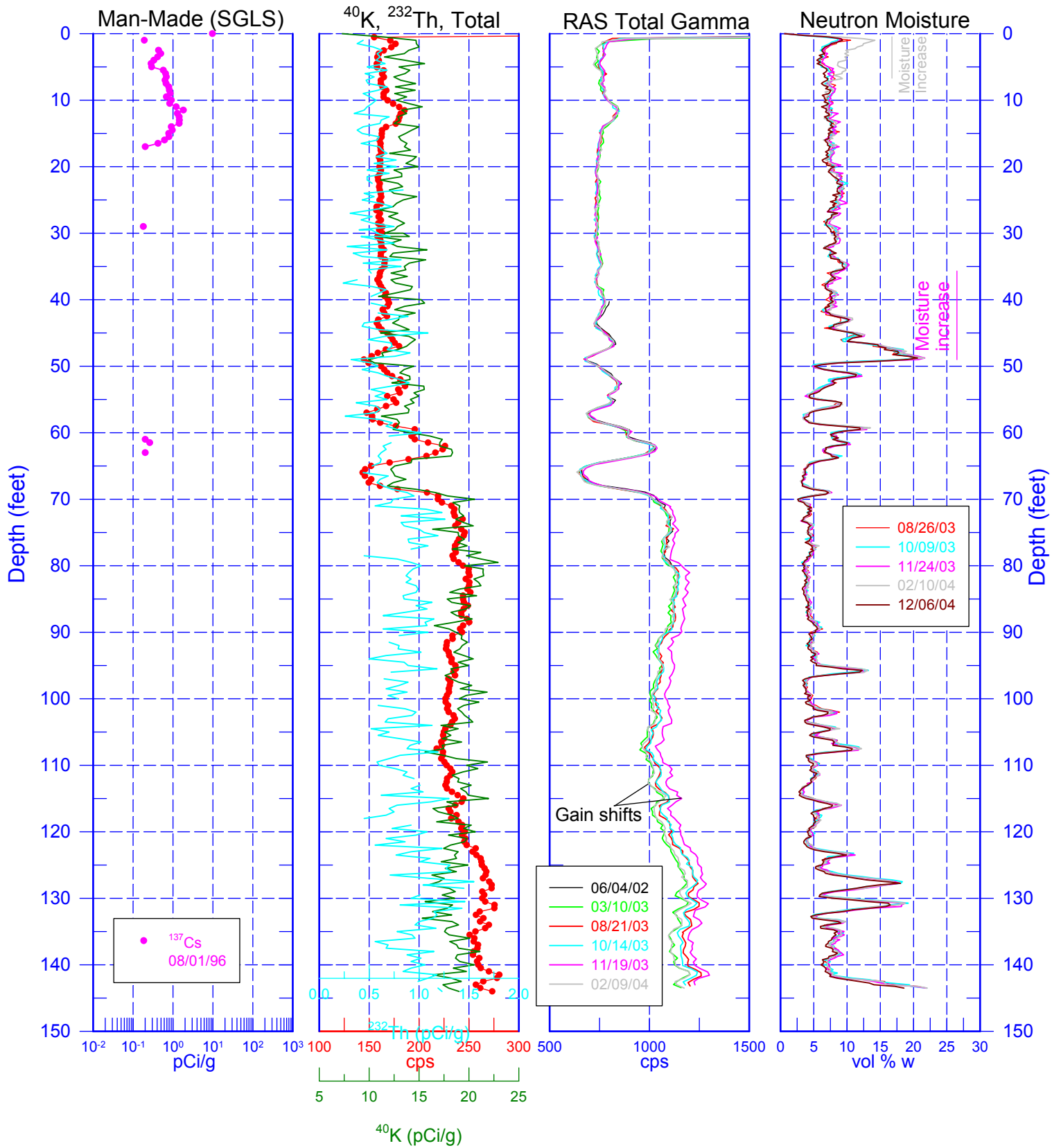
Tank S-112

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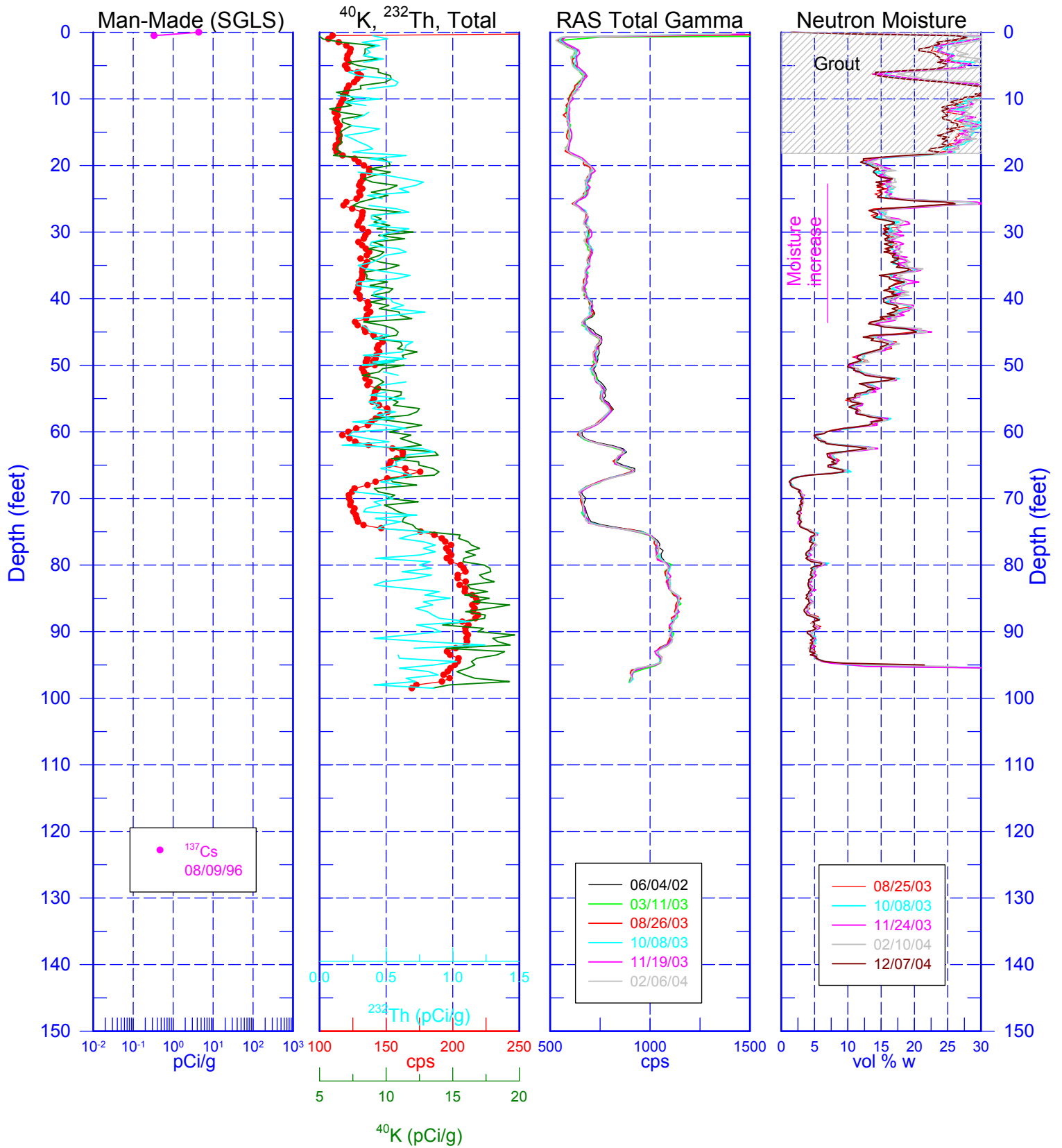
Tank S-112

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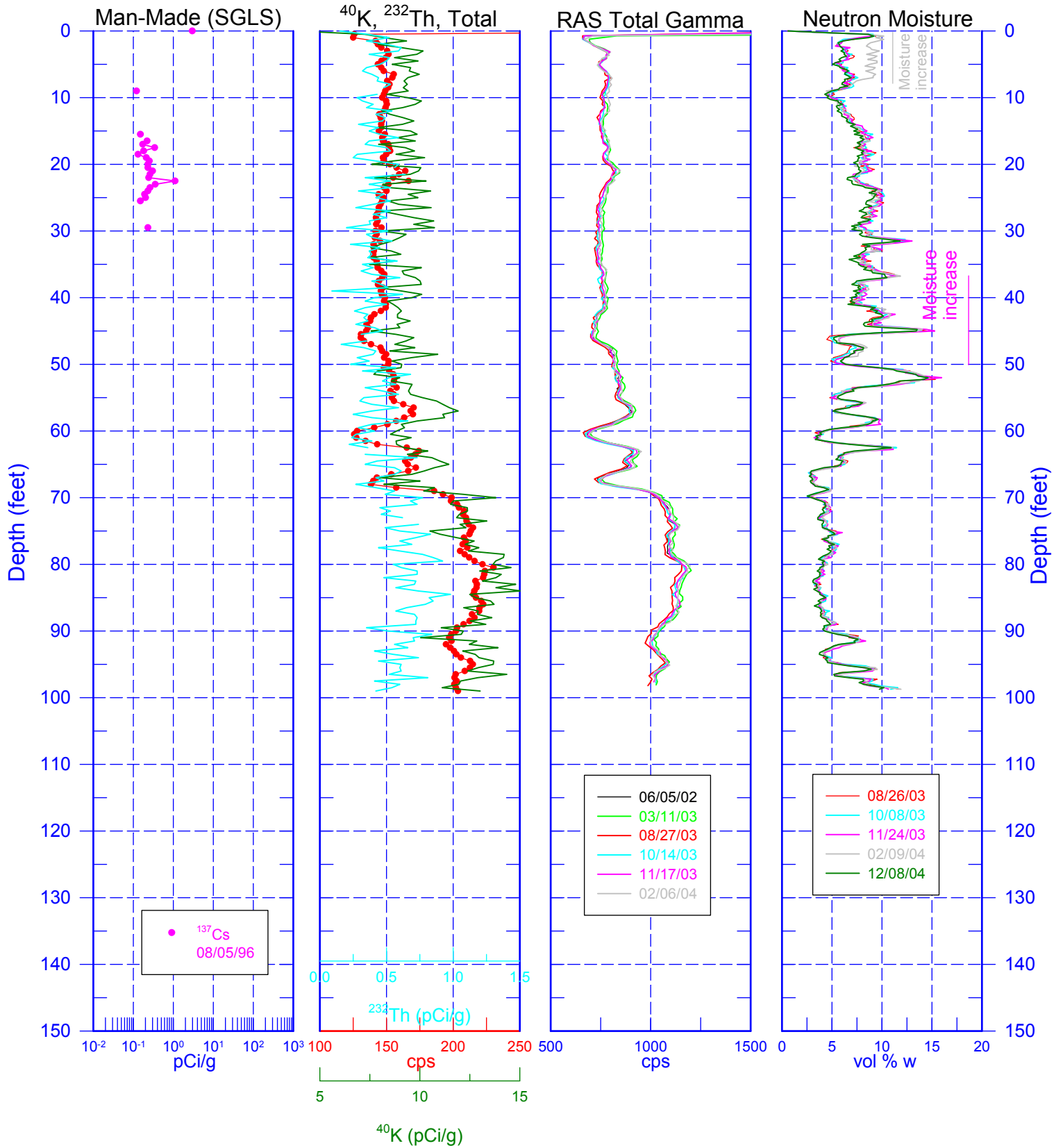
Tank S-112

40-12-07



Tank S-112

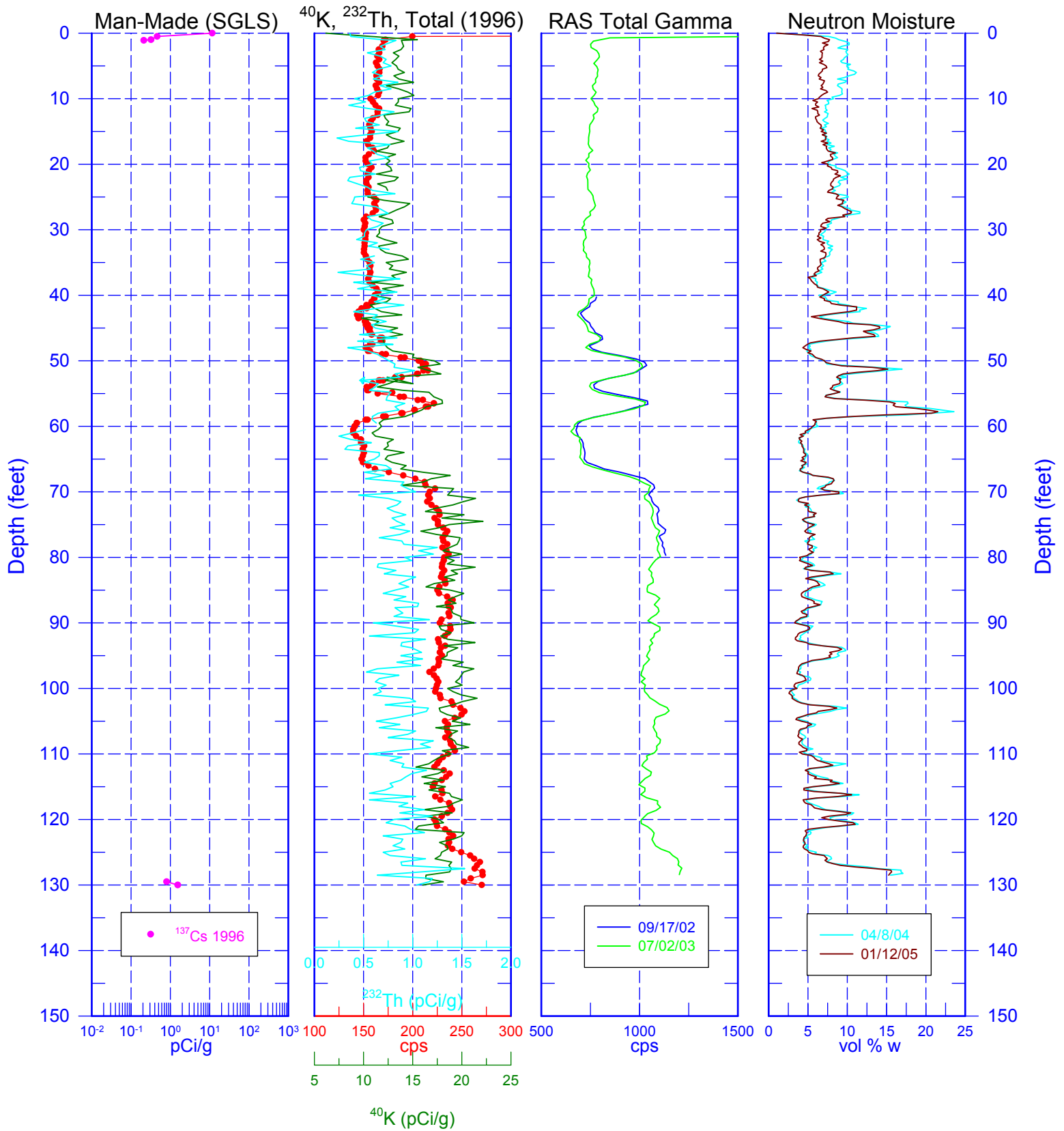
40-12-09



Appendix D
Tank S-102 Retrieval Monitoring Log Plots

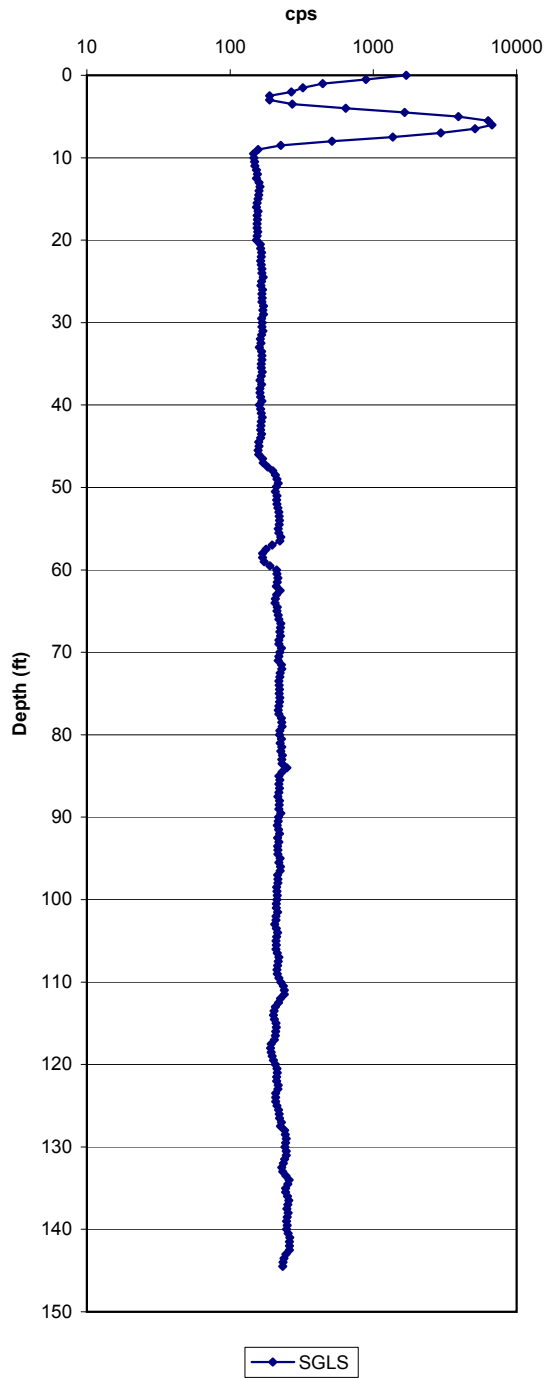
Tank S-102

40-02-01

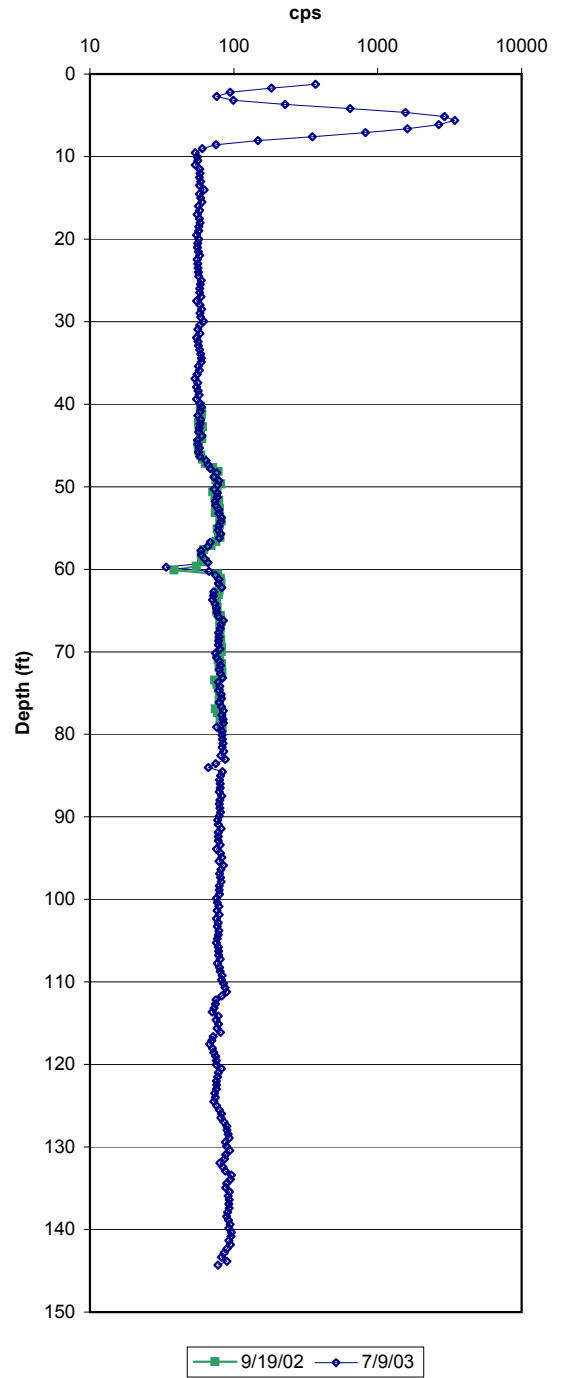


Borehole 40-02-04

SGLS Total Gamma
Log Date: 5/23/96

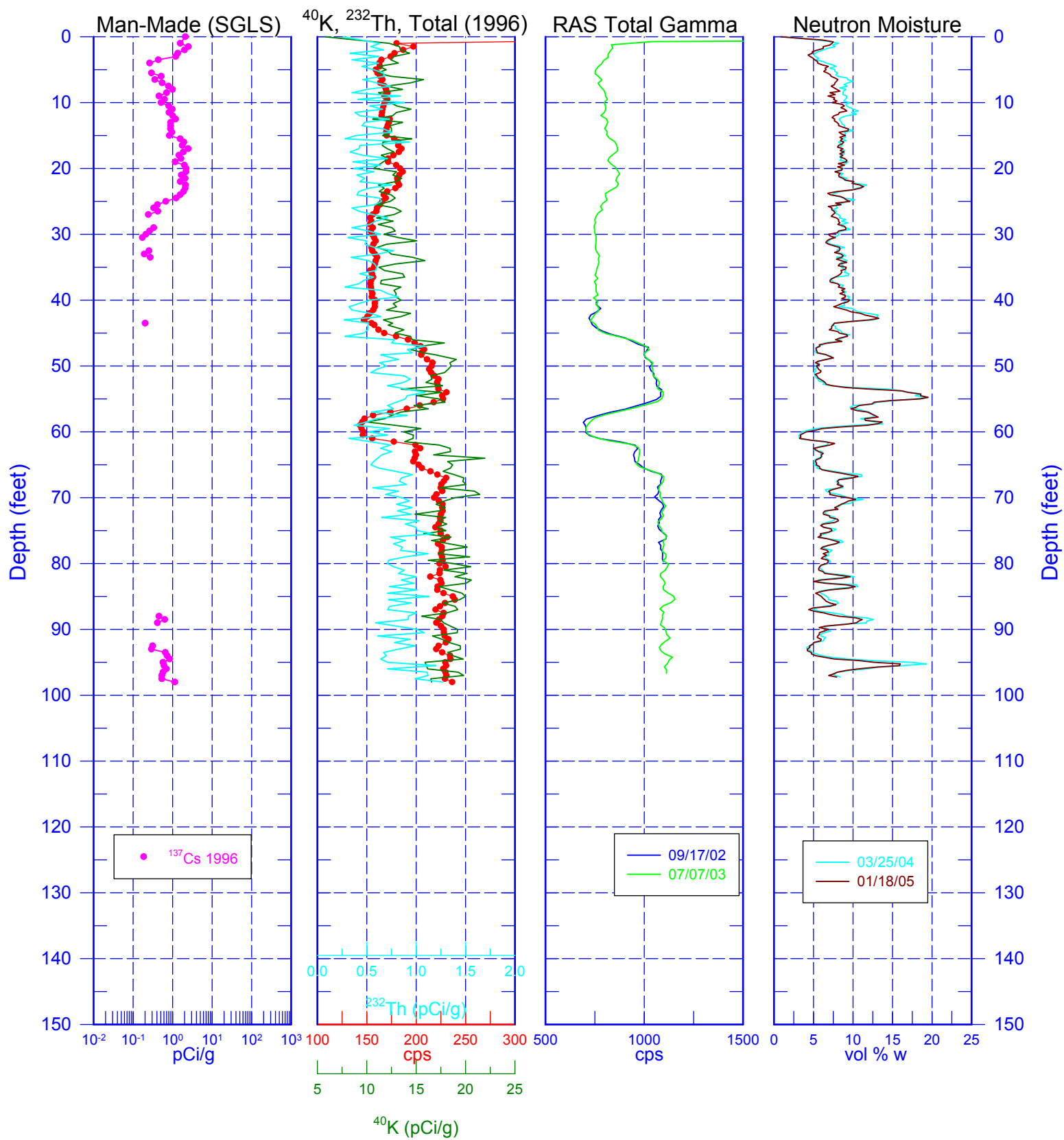


RAS Total Gamma (Medium Detector)
Log Date: See Legend Below



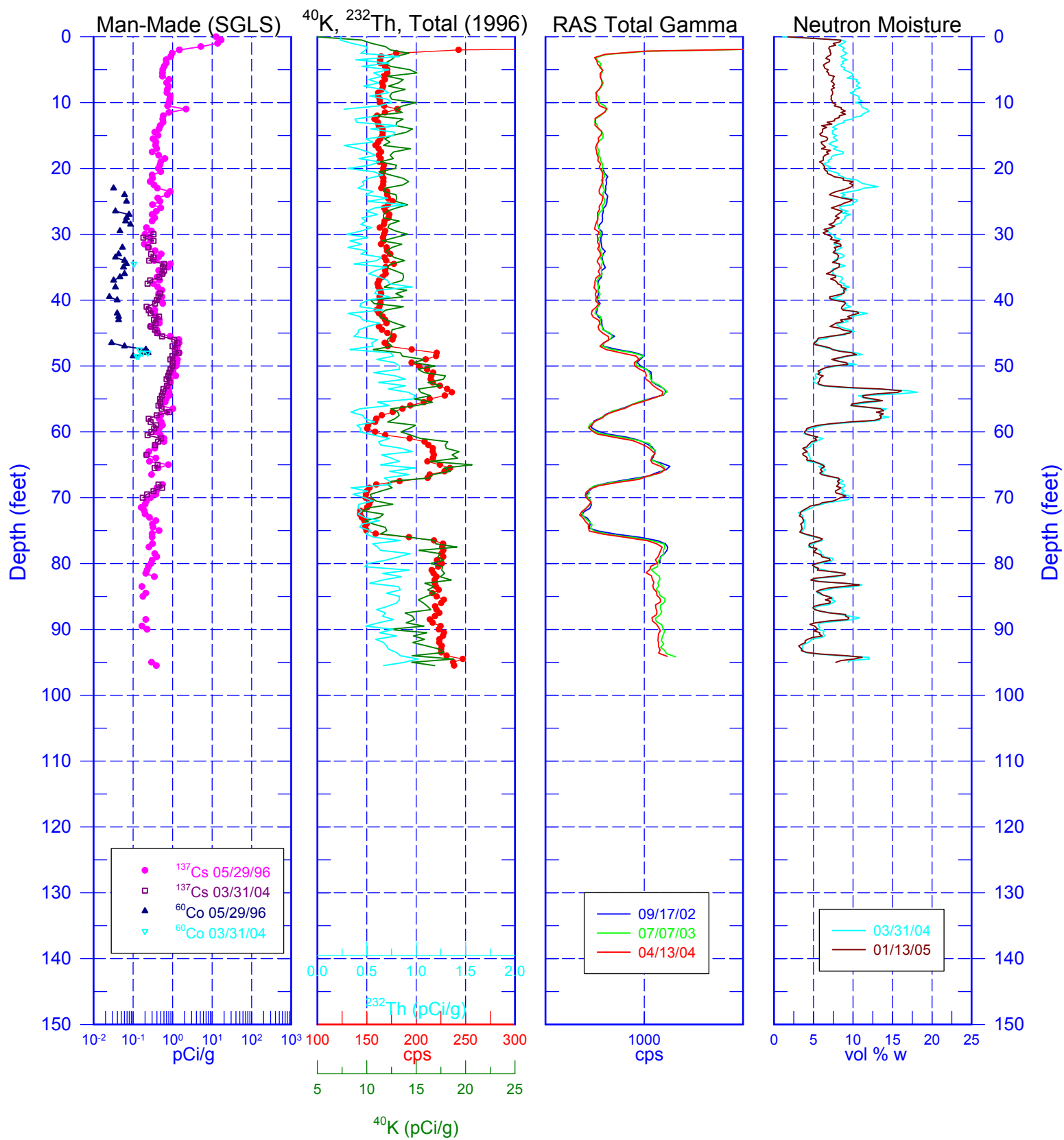
Tank S-102

40-02-05



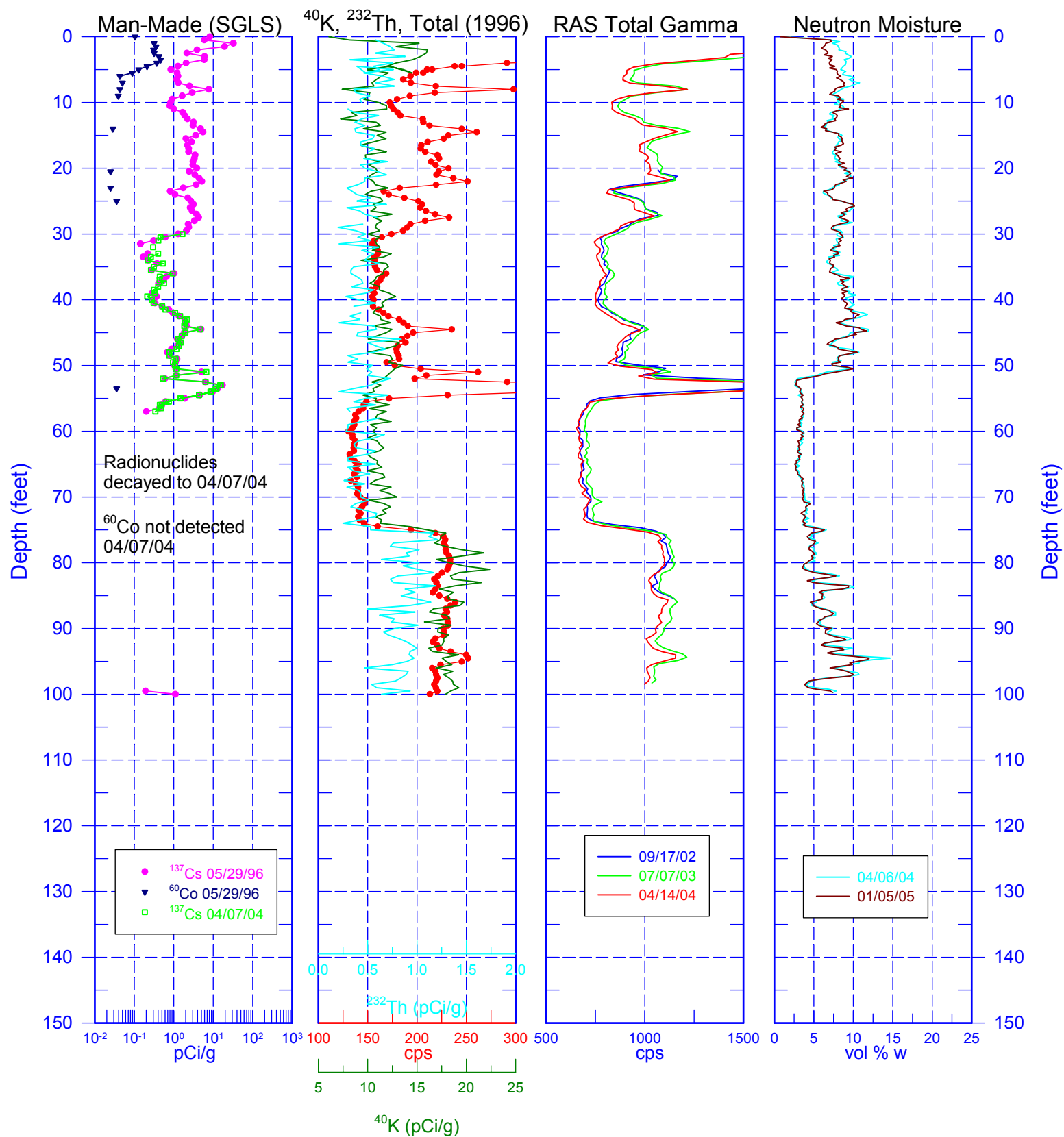
Tank S-102

40-02-07



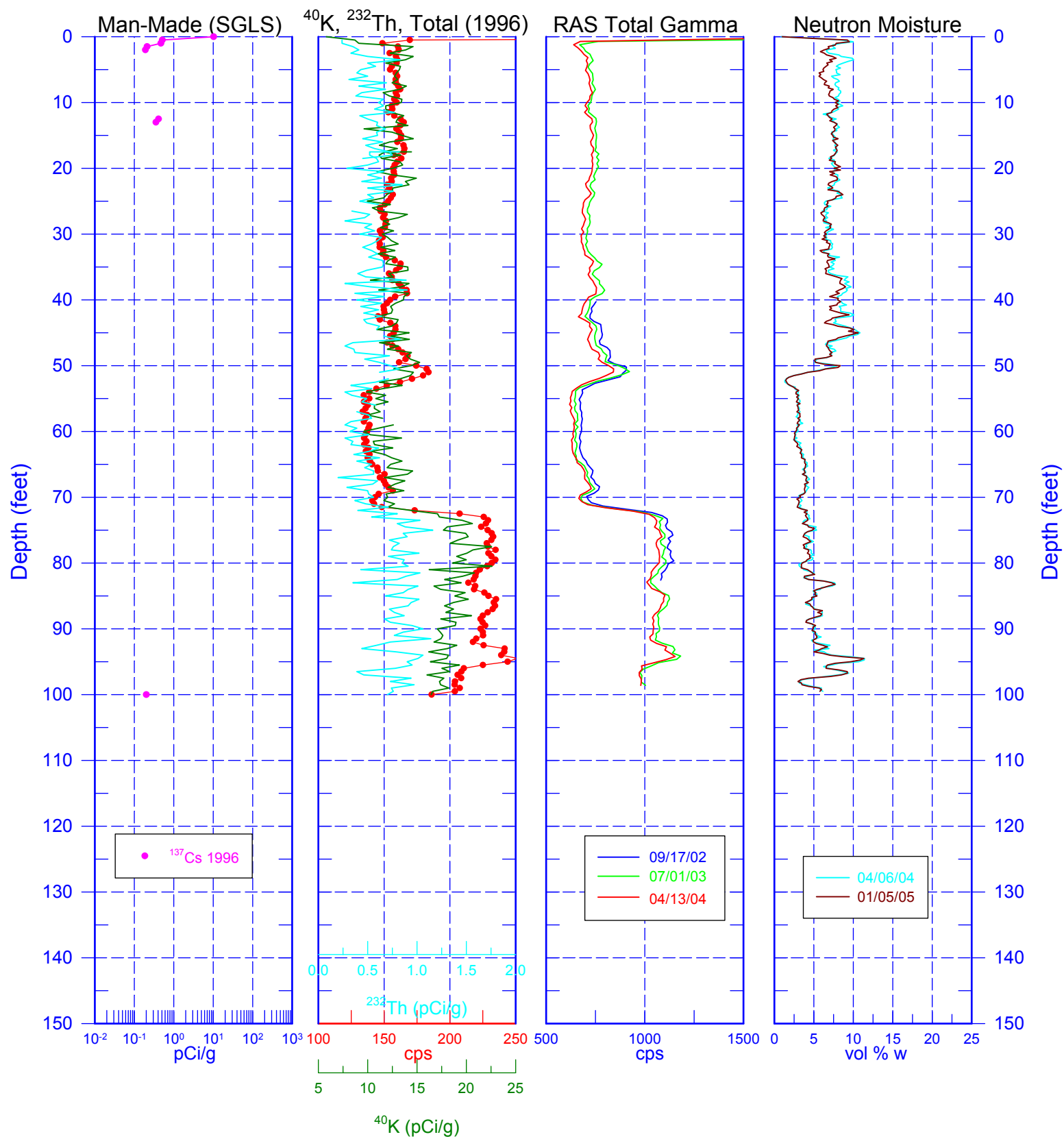
Tank S-102

40-02-08



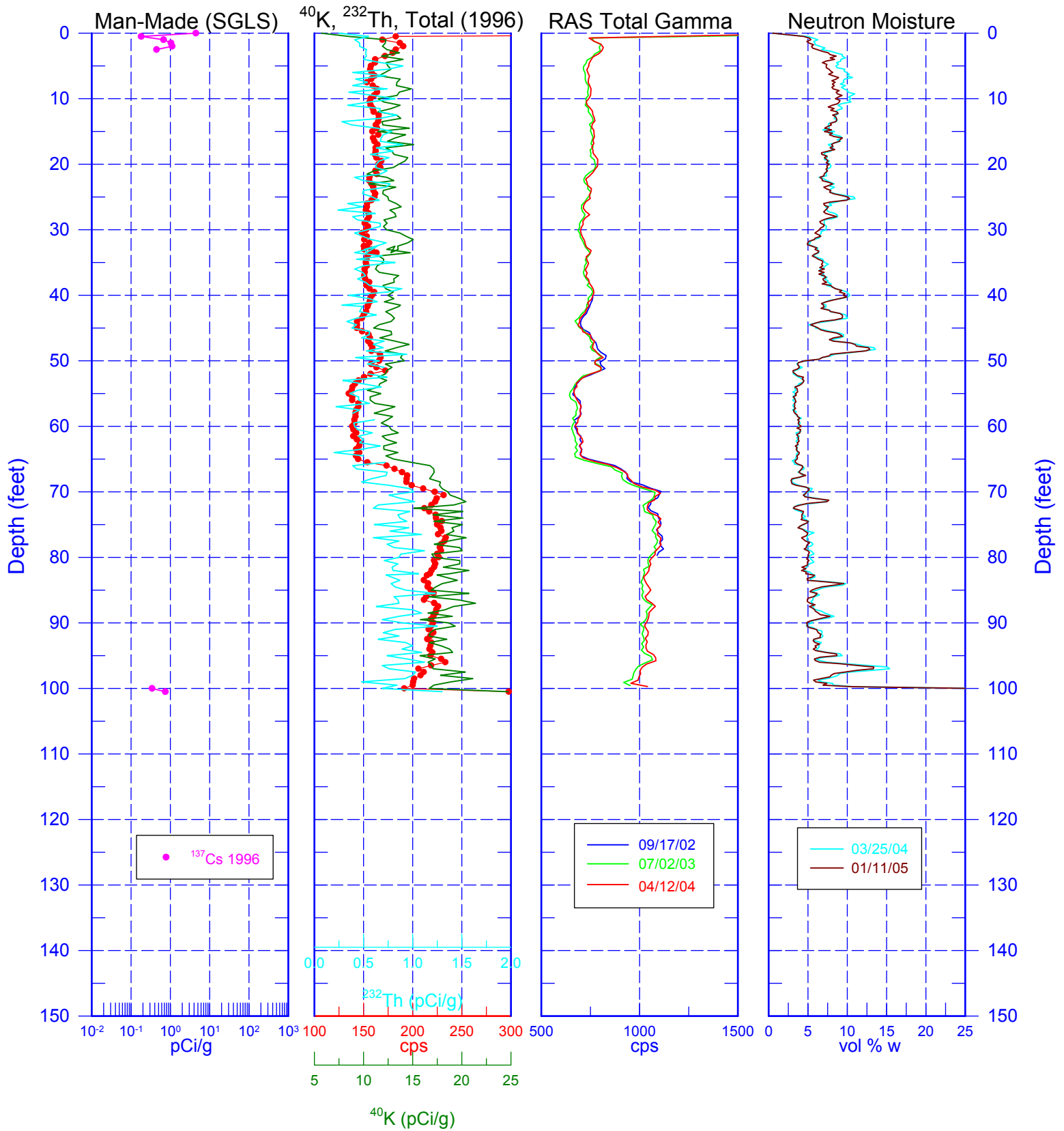
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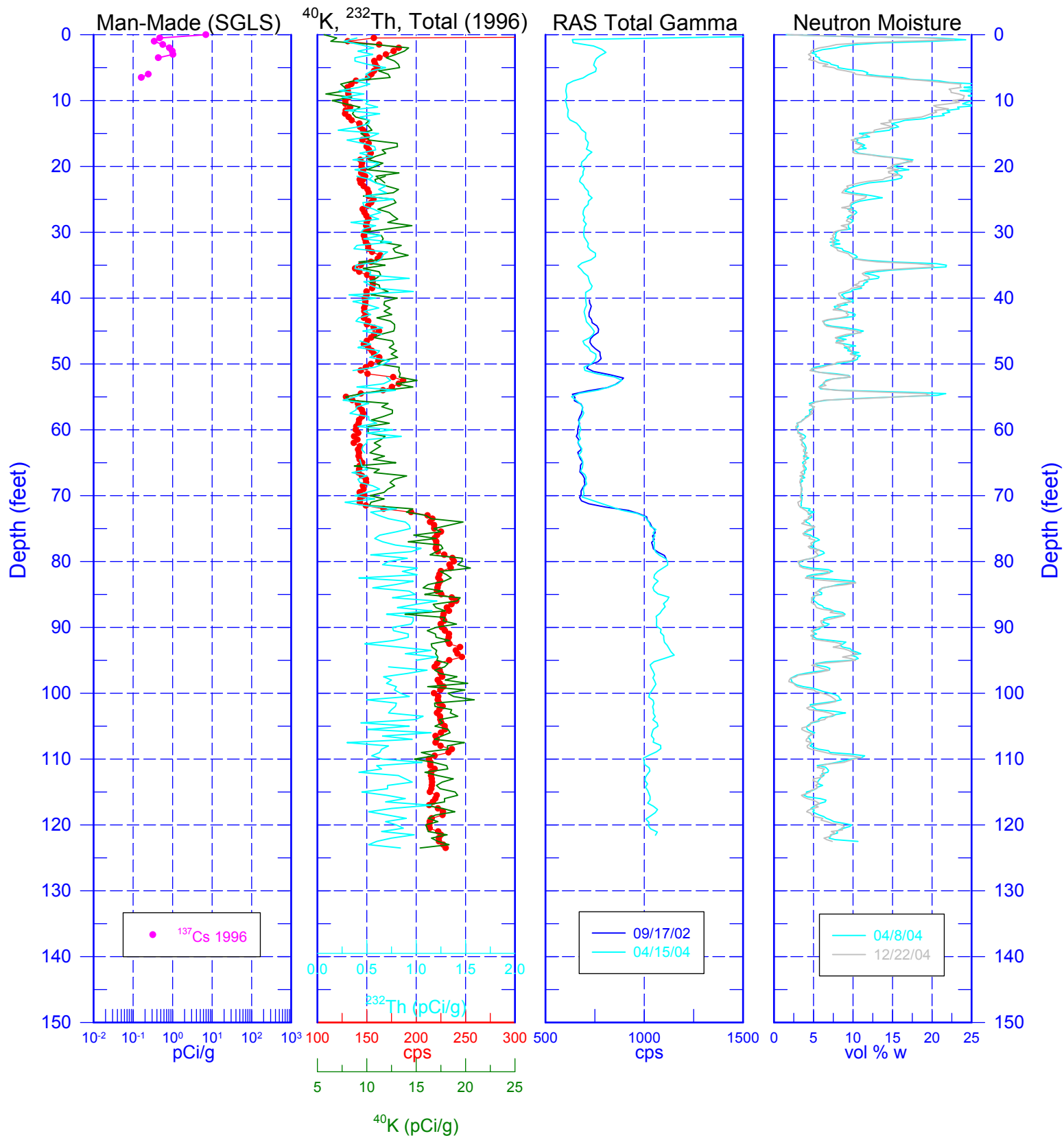
Tank S-102

40-02-11



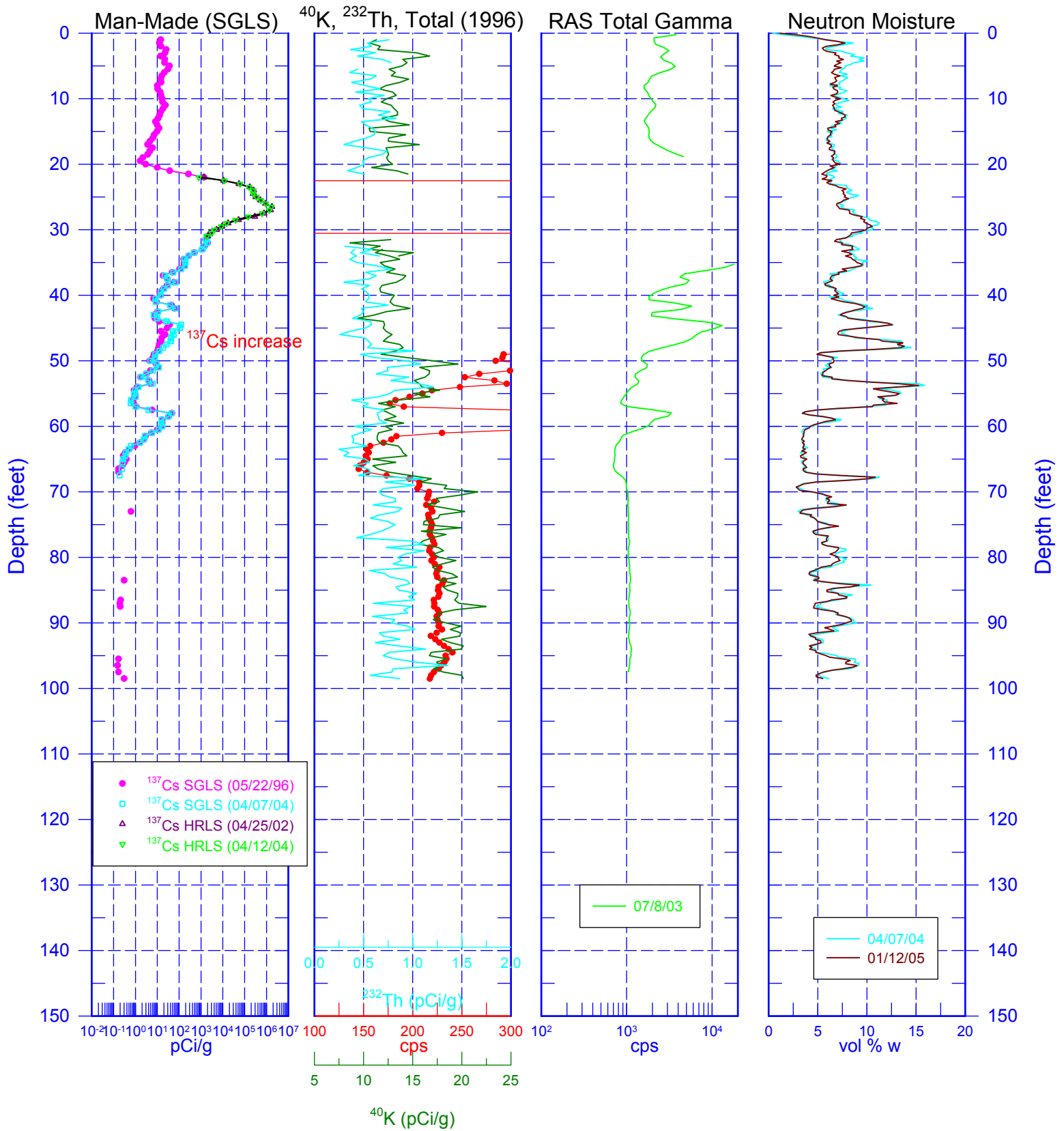
Tank S-102

40-03-03



Tank S-102

40-02-03



Appendix E
AX-103 Drywell Investigation Summary Report

AX-103 Drywell Investigation Summary Report

Introduction:

The purpose of this letter report is to summarize results of recent Radionuclide Assessment System (RAS) data collected in drywells adjacent to Single-Shell Tank 241-AX-103. RAS monitoring was initiated at the request of CH2M HILL in response to a drop in liquid level observed in December 2004. Seven drywells adjacent this tank were monitored between January and March 2005. Evaluations of this data with respect to previous RAS data and Spectral Gamma Logging System (SGLS) baseline data collected in 1996 showed no evidence of any anomalous increase in gamma activity that would be indicative of a leak.

Background:

Tank 241-AX-103 is one of four single-shell tanks in the AX Tank Farm in the Hanford 200 East Area. Constructed during 1963 to 1964, and placed in service in 1965, Tank AX-103 has a nominal capacity of 1 million gallons. The tank is a vertical cylinder, 75 ft in diameter and 32.5 ft tall, consisting of a 24-in.-thick reinforced concrete wall and floor with a 3/8-in. steel liner. The top of the tank is covered with an unlined concrete dome and the entire structure is buried, such that the base of the tank is approximately 55 ft below grade. Tank AX-103 is classified as sound and interim stabilized. Total waste inventory is 107,000 gallons, which includes 99,000 gallons of salt cake and 8,000 gallons of sludge. The tank is also reported to contain 22,000 gallons of drainable interstitial liquid (Hanlon 2004)

On December 12, 2004, a routine quarterly measurement in the liquid observation well (LOW) in Tank AX-103 indicated a decrease in liquid level of 2.7 in. relative to the baseline value. The previous reading had been made on July 5, 2004. Tank AX-103 is currently designated as "sound" and does not require Leak Detection Monitoring (LDM) per *SST Leak Detection and Monitoring Functions and Requirements* (Barnes 2003). LOW monitoring is performed to detect liquid intrusion. The ENRAF™ in Tank AX-103 has shown no change over the last two years, but the LOW is the official instrument designated in *SST Leak Detection and Monitoring Functions and Requirements*. The ENRAF™ is resting on a solid surface and would not be expected to respond to a leak. However, the reported presence of 22,000 gallons of drainable interstitial liquid implies that a leak is conceivable.

The drop in liquid level prompted an occurrence report (2004-0070) and raised concern that a leak may have occurred in the tank. Stoller was first informed of the liquid level drop on December 21, 2004, and a request was made on December 27, 2004 to conduct

monitoring in adjacent drywells. Neutron moisture logging was briefly considered, but rejected because of the lack of any baseline information against which to compare logs. In the absence of any previous data, small variations in moisture associated with stratigraphic variation and/or infiltration of precipitation would be indistinguishable from moisture anomalies representative of a minor leak. Plans were made to use the radionuclide assessment system to collect gamma data for comparison with prior RAS data and baseline data collected in 1996 by the SGLS.

Available Log Data:

Seven drywells surrounding Tank AX-103 were identified for monitoring. However, the RAS is operated by CH2M HILL personnel, and available operators trained to operate the RAS were assigned to higher priority projects by CH2M HILL. One drywell was monitored in mid-January, three were monitored in early February, and the remaining three were monitored in early March. Table 1 summarizes available SGLS and RAS data for drywells adjacent to Tank AX-103. Baseline vadose zone conditions are described in *Vadose Zone Characterization Project at the Hanford Tank Farms, Tank Summary Data Report for Tank AX-103* (DOE 1997).

Table 1. Available Drywell Data, Tank AX-103

Drywell	System	Log Date
11-03-02	SGLS	9/13/96
	RAS (Large Detector)	6/13/02
	RAS (Large Detector)	6/11/03
	RAS (Large Detector)	1/17/05
11-01-09	SGLS	8/26/96
	RAS (Large Detector)	9/26/02
	RAS (Large Detector)	3/02/05
11-03-05	SGLA	9/13/96
	RAS (Large Detector)	3/02/05
11-03-07	SGLA	9/17/96
	RAS (Large Detector)	3/01/05
11-03-09	SGLS	9/18/96
	RAS (Large Detector)	6/11/03
	RAS (Large Detector)	2/03/05
11-03-10	SGLS	9/17/96
	RAS (Large Detector)	2/03/05
11-03-12	SGLS	9/12/96
	RAS (Large Detector)	2/03/05

Figure 1 shows the location of drywells with respect to Tank AX-103. Comparison plots of man-made gamma-emitting radionuclides in each borehole are provided in Figure 2. These plots are based on SGLS data collected in 1996 and originally reported in *Vadose Zone Characterization Project at the Hanford Tank Farms, Tank Summary Data Report for Tank AX-103* (DOE 1997). Figure 3 shows comparison plots of RAS total gamma activity for each borehole adjacent to Tank AX-103. These plots show total gamma activity in the region from 10 ft above the base of the tank farm excavation to 10 ft

below. In three boreholes, RAS data had been collected prior to December 2004 as part of the routine monitoring program, and comparison with results collected later show no evidence of any significant increase in gamma activity. In boreholes 11-03-02 and 11-01-09, a slight decrease in count rate is seen; this decrease is attributed to a loss of efficiency when the RAS large detector was repaired.

Results from individual boreholes will be discussed in detail below, beginning with borehole 11-03-02, and proceeding clockwise around the tank.

Borehole 11-03-02:

Borehole 11-03-02 is located approximately 3 ft northeast of Tank AX-103. It was given the Hanford Site designation 299-E25-113. This borehole was drilled in January 1975 and completed to a depth of 100 ft using 6-in. casing.

The man-made radionuclides detected in this borehole during the 1996 baseline log event were cesium-137 (^{137}Cs), cobalt-60 (^{60}Co), and antimony-125 (^{125}Sb). ^{137}Cs contamination was detected at high levels from the ground surface to 26 ft and from 33.5 to 37 ft. Moderate to low levels of ^{137}Cs contamination were also detected to a depth of 83 ft and at the bottom of the borehole.

^{60}Co contamination was detected continuously between 3.5 and 10.5 ft, between 13 and 14 ft, between 15 and 16 ft, and at 23.5 and 24.5 ft. The highest ^{60}Co concentration was about 9 pCi/g within the first zone at 3.5 ft. This zone also contains the highest ^{137}Cs concentrations. Other peaks in the measured ^{60}Co concentrations were about 0.5 pCi/g between 13 and 14 ft and about 1 pCi/g between 15 and 16 ft. Other measured ^{60}Co concentrations were just above the minimum detection level (MDL) at about 0.1 pCi/g.

Scattered ^{125}Sb concentrations were detected at 10.5, 34.5, and 36 ft. The highest concentration was about 30 pCi/g at 10.5 ft.

Evaluation of historical gross gamma data and comparison with the baseline spectral gamma data indicates that the zone of anomalous gamma-ray activity has remained relatively stable between 1975 and 1995.

Figure 4 shows SGLS and RAS total gamma plots for 11-03-02. Both logs exhibit similar character; RAS data collected on January 17, 2005 (approximately 1 month after the level decrease was observed in the LOW) show no significant difference from earlier RAS data.

Borehole 11-01-09:

Borehole 11-01-09 is located approximately 2 ft from the east side of Tank AX-103 and was given the Hanford Site designation 299-E25-104. This borehole was drilled in December 1974 to a depth of 100 ft and was completed with 6-in. casing. The present top of the casing, which is the zero depth reference for the SGLS logs, is located on the

side of a soil berm approximately 1.5 ft higher in elevation than the average tank farm grade. The drilling log does not mention if the casing was perforated or grouted. The total logging depth achieved by the SGLS was 103 ft, indicating that a section of casing may have been added after the elevation survey was completed.

^{137}Cs was the only man-made radionuclide detected in this borehole during the 1996 baseline log event. It was detected almost continuously from the ground surface to 32 ft. Detectable quantities (less than 0.5 pCi/g) were noted at 54.5 ft and the bottom of the borehole (103 ft). The maximum ^{137}Cs concentration was 12 pCi/g at the ground surface and about 10 pCi/g within the near-surface continuous zone.

Figure 5 shows SGLS and RAS total gamma plots for 11-01-09. The RAS total gamma data exhibits characteristics similar to the 1995 SGLS baseline log; the RAS data collected on March 2, 2005 is similar to the RAS data collected on September 26, 2002. The slight decrease in counts between the 2002 and 2005 measurements is most likely related to a minor loss of efficiency resulting from resurfacing of the RAS detector crystal.

Borehole 11-03-05:

Borehole 11-03-05 is located approximately 3.5 ft from the southeast side of Tank AX-103. It was given the Hanford Site designation 299-E25-114. This borehole was drilled in December 1974 to a depth of 100 ft and completed with 6-in. casing. The drilling log does not indicate if the casing was perforated or grouted. The maximum logging depth achieved by the SGLS was 100 ft.

The only man-made radionuclide detected in this borehole during the 1996 baseline log event was ^{137}Cs . ^{137}Cs concentrations were detected continuously from the ground surface to a depth of 4 ft. Detectable quantities of less than 0.25 pCi/g were encountered at 6.5, 10.5, and 55 ft. The maximum ^{137}Cs concentration was about 10 pCi/g.

No monitoring events have been performed in 11-03-05 since completion of the baseline in 1996. The RAS total gamma data collected on March 2, 2005 is similar to in character to the 1996 SGLS baseline log, and indicates background activity levels (Figure 6). No indication of anomalous gamma activity is observed.

Borehole 11-03-07:

Borehole 11-03-07 is located approximately 3.5 ft from the southwest side of Tank AX-103 and was given the Hanford Site designation 299-E25-115. This borehole was drilled in February 1975 to a depth of 100 ft and completed with 6-in. casing. The drilling log does not indicate if the casing was perforated or grouted.

The top of the casing is the zero reference for the log of this borehole. The top of the casing elevation in this borehole is 683 ft above mean sea level and is approximately 3 ft higher than the tops of the casing elevations of other boreholes in the area. The total

logging depth achieved by the SGLS was 103 ft, indicating that a section of casing was added after the borehole was completed.

Man-made radionuclides detected in this borehole during the 1996 baseline log event were ^{137}Cs , ^{60}Co , and europium-154 (^{154}Eu). ^{137}Cs contamination was detected continuously from the ground surface to 30 ft. The maximum ^{137}Cs concentrations were detected within the upper 10 ft of the borehole. A zone of elevated ^{137}Cs contamination with measured concentrations of about 100 pCi/g was detected between 5 and 8 ft. ^{137}Cs concentrations below 10 ft ranged from 1 to 2 pCi/g. ^{137}Cs concentrations of less than 1 pCi/g were detected intermittently between 33.5 and 40.5 ft.

The highest measured concentrations of ^{60}Co and ^{154}Eu were detected continuously within the zone of elevated ^{137}Cs contamination between 5 and 8 ft. The highest ^{60}Co concentration was 2 pCi/g at 6 ft, and the highest ^{154}Eu concentration was 17 pCi/g at 6.5 ft.

No monitoring events have been performed in 11-03-07 since completion of the baseline in 1996. The RAS total gamma data collected on March 1, 2005 is similar to in character to the 1996 SGLS baseline log, and indicates background activity levels below 30 ft depth (Figure 7). No indication of anomalous gamma activity is observed.

Borehole 11-03-09:

Borehole 11-03-09 is located approximately 3 ft from the west side of Tank AX-103 and was given the Hanford Site designation 299-E25-116. This borehole was drilled in January 1975 to a depth of 120 ft and completed with 6-in. casing. The drilling log does not indicate if this borehole was perforated or grouted. The total logging depth achieved by the SGLS was 119.5 ft.

The only man-made radionuclide detected in this borehole during the 1996 baseline log event was ^{137}Cs . The ^{137}Cs contamination was detected continuously from the ground surface to about 6 ft and intermittently to 12 ft. Detectable quantities of less than 2 pCi/g were noted from 44.5 to 45 ft and from 52.5 to 53 ft. The maximum concentration of ^{137}Cs was 7.5 pCi/g at 1.5 ft. The measured ^{137}Cs concentration at the ground surface was about 4 pCi/g.

RAS monitoring events were performed in 11-03-09 on June 11, 2003 and February 3, 2005. There is no discernable difference in the two total activity plots, both of which are consistent with background activity below 30 ft. Figure 8 shows SGLS and RAS total activity plots for 11-03-09.

Borehole 11-03-10:

Borehole 11-03-10 is located approximately 4 ft from the northwest side of Tank AX-103 and was given the Hanford Site designation 299-E25-117. This borehole was drilled in January 1975 to a depth of 100 ft and completed with 6-in. casing. The drilling log does

not indicate if this borehole was perforated or grouted. The total logging depth achieved by the SGLS was 99 ft.

The only man-made radionuclide detected in this borehole during the 1996 baseline log event was ^{137}Cs . The ^{137}Cs contamination was detected continuously from the ground surface to about 14.5 ft and intermittently from 14.5 to 35.5 ft. Detectable ^{137}Cs quantities of less than 0.3 pCi/g were noted from 44.5 to 46.5 ft, at 50.5 ft, from 66 to 68 ft, and at the bottom of the borehole. The maximum ^{137}Cs concentration was 7 pCi/g at the ground surface.

No logs had been run in 11-03-10 since completion of the baseline in 1996. The RAS total gamma data collected on February 3, 2005 is similar to in character to the 1996 SGLS baseline log, and indicates background activity levels below 30 ft depth (Figure 9). No indication of anomalous gamma activity is observed.

Borehole 11-03-12:

Borehole 11-03-12 is located approximately 1.5 ft north of Tank AX-103 and was given the Hanford Site designation 299-E25-118. This borehole was drilled in December 1974 to a depth of 100 ft and completed with 6-in. casing. The drilling log does not indicate if this borehole was perforated or grouted. The total logging depth achieved by the SGLS was 99.5 ft.

The man-made radionuclides detected in this borehole during the 1996 baseline log event were ^{137}Cs , ^{60}Co , and ^{125}Sb . The ^{137}Cs contamination was detected continuously at moderate concentrations from 10 to 40 pCi/g between the ground surface and about 6 ft and at low concentrations from 0.2 to 1 pCi/g between 6 and 18 ft. Quantities of ^{60}Co were detected within the near-surface ^{137}Cs -contaminated zone at 5 ft and between 10.5 and 11.5 ft. The highest measured concentration of ^{60}Co was 0.14 pCi/g at 11 and 11.5 ft. Detectable concentrations of ^{125}Sb were encountered between 9 and 13 ft. The highest concentration of ^{125}Sb was 1.8 pCi/g at 12.5 ft. Distinct zones of ^{137}Cs contamination were detected at concentrations from 0.2 to 1 pCi/g between 37.5 and 43.5 ft and at 52 and 53 ft. ^{137}Cs concentrations measuring less than 0.2 pCi/g were detected from 27 to 27.5 ft and at the bottom of the borehole (99.5 ft).

No monitoring events had been performed in 11-03-12 since completion of the baseline in 1996. The RAS total gamma data collected on February 3, 2005 is similar to in character to the 1996 SGLS baseline log, and indicates background activity levels below 30-ft depth (Figure 10). No indication of anomalous gamma activity is observed.

Conclusions:

SGLS baseline data indicate that near-surface gamma-emitting contamination detected in the vicinity of Tank AX-103 appears to be related to surface spills and/or pipeline leaks that have penetrated into the soil. The contamination between the ground surface and 5 ft probably resulted from surface spills that migrated down into the backfill surrounding the

boreholes. The contamination detected in the deeper portions of the backfill (below 5 ft) is probably the result of a subsurface leak from a transfer line or connection points near the tank. Evaluation of historical gross gamma data suggests that most, if not all of this contamination was present prior to 1975 and has not migrated any significant distance in the intervening years. The baseline summary report for Tank AX-103 concluded that there was no evidence of a leak up to 1996 (DOE 1997). Comparison of subsequent RAS monitoring events against the baseline data did not detect any evidence of increased gamma activity, and it is concluded that there is no indication of a tank leak in the most recent RAS data. However, Tank AX-103 is 75 ft in diameter; there are only seven boreholes around a circumference of approximately 236 ft, and no monitoring points beneath the tank. It is possible that a leak may have occurred but that the plume has not yet intersected a drywell.

Recommendations:

A renewed priority needs to be placed on routine monitoring. The 2.7-in. level drop reported in December was based on comparison with the most recent measurement taken in July, approximately five months previously. Therefore, it is impossible to determine if the reported change occurred suddenly or gradually within that time period. When the level drop was reported, four of the seven drywells adjacent to Tank AX-103 had not been monitored since the baseline was completed in 1996. The routine monitoring plan calls for each drywell to be monitored at least once in a 5-year period, but there is only one monitoring system for 749 drywells in 12 tank farms. This system is operated by the tank farm contractor, and available operators are frequently assigned to other work. Even though the liquid level drop in AX-103 raised the possibility of a tank leak and led to an urgent request for monitoring data, it took more than three months to collect monitoring data in seven drywells. This delay was due entirely to a lack of operator support.

The liquid level drop in AX-103 does not appear to be an indication of a leak of tank waste into the vadose zone. However, the current inventory of 22,000 gallons of drainable interstitial liquid in the tank suggests that loss of contaminated material to the vadose zone is still possible. This incident should serve as a reminder that tank conditions are by no means static and routine monitoring is essential to provide timely warning of potential hazards to the vadose zone and groundwater.

The need to reemphasize the routine drywell monitoring program is extremely clear. Operator availability and tank farm access restrictions have effectively deferred the routine drywell monitoring program indefinitely. A recent RAS status report (March 17, 2005) indicates that 130 drywells have been scheduled for monitoring between October 1, 2004 and March 17, 2005, and that monitoring was performed in only 11 boreholes during that period. All of these have been in drywells adjacent to tanks undergoing retrieval operations. The AX-103 event should be considered a “near miss” and should serve as a wake-up call. Although most individuals familiar with the tank suspected the LOW behavior was not indicative of a leak, there was little data to confirm this, and collection of drywell data was delayed more than three months. In the event a significant gamma anomaly had been detected in a drywell, notifications and corrective

actions would have been perceived as extremely slow. Since four of the seven drywells had not been monitored at all in almost 10 years, it would be impossible to establish the time frame in which the anomaly occurred. This could lead to the possibility that migration of pre-existing plumes and/or contamination from a surface spill or pipeline leak would be mis-identified as a tank leak.

Drywell monitoring around AX-103 should be performed on a quarterly basis for at least two or three quarters. The absence of detectable increases in gamma activity in seven drywells distributed around a 75-ft diameter structure cannot be taken as definitive proof that no leak occurred. It is always possible that a leak occurred at a location remote from the monitoring wells, and that time will be required for contamination to migrate within the detection radius of a drywell. As more data become available, the monitoring interval can be extended, particularly if in-tank measurements show no that the decline in liquid level has stabilized.

It is possible that liquid associated with a tank leak may not necessarily have high gamma activity, and that a sudden increase in subsurface moisture content may be an indication of a tank leak. However, current moisture conditions in the tank farm vadose zone are not well known, and the degree to which moisture conditions fluctuate with seasonal variations and infiltration of precipitation is also poorly understood. In the absence of a baseline against which to compare, any localized increase in moisture around Tank AX-103 would be indistinguishable from a tank leak. Quarterly gamma monitoring activities should also include neutron moisture measurements. This will improve the overall understanding of subsurface moisture conditions and provide a baseline for detection of anomalous activity in the future.

References:

Barnes, D.A. 2003. *Single Shell Tank System Leak Detection and Monitoring Functions and Requirements Document*, RPP-9937, Rev. B, CH2M HILL Hanford Group, Inc., Richland, Washington.

Hanlon, B.M. 2005. *Waste Tank Summary Report for Month Ending November 30, 2004*, HNF-EP-0182, Rev. 200, CH2M HILL Hanford Group, Inc, Richland, Washington.

U.S. Department of Energy (DOE), 1997. *Vadose Zone Characterization Project at the Hanford Tank Farms, Tank Summary Data Report for Tank AX-103*, GJ-HAN-51, prepared by MACTEC-ERS for the Grand Junction Office, Grand Junction, Colorado.

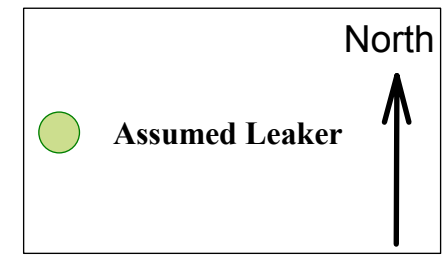
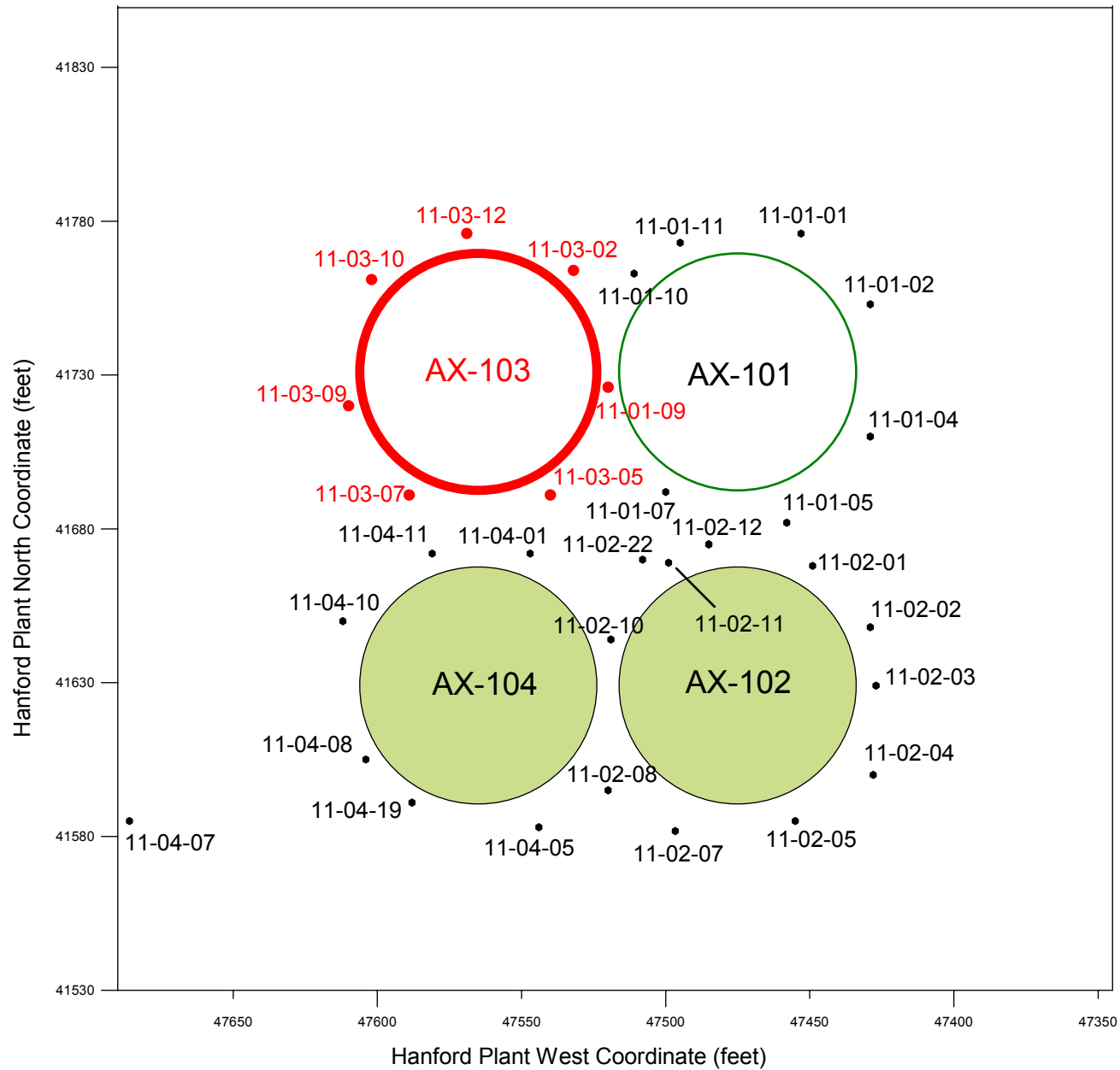


Figure 1
AX-103 Map

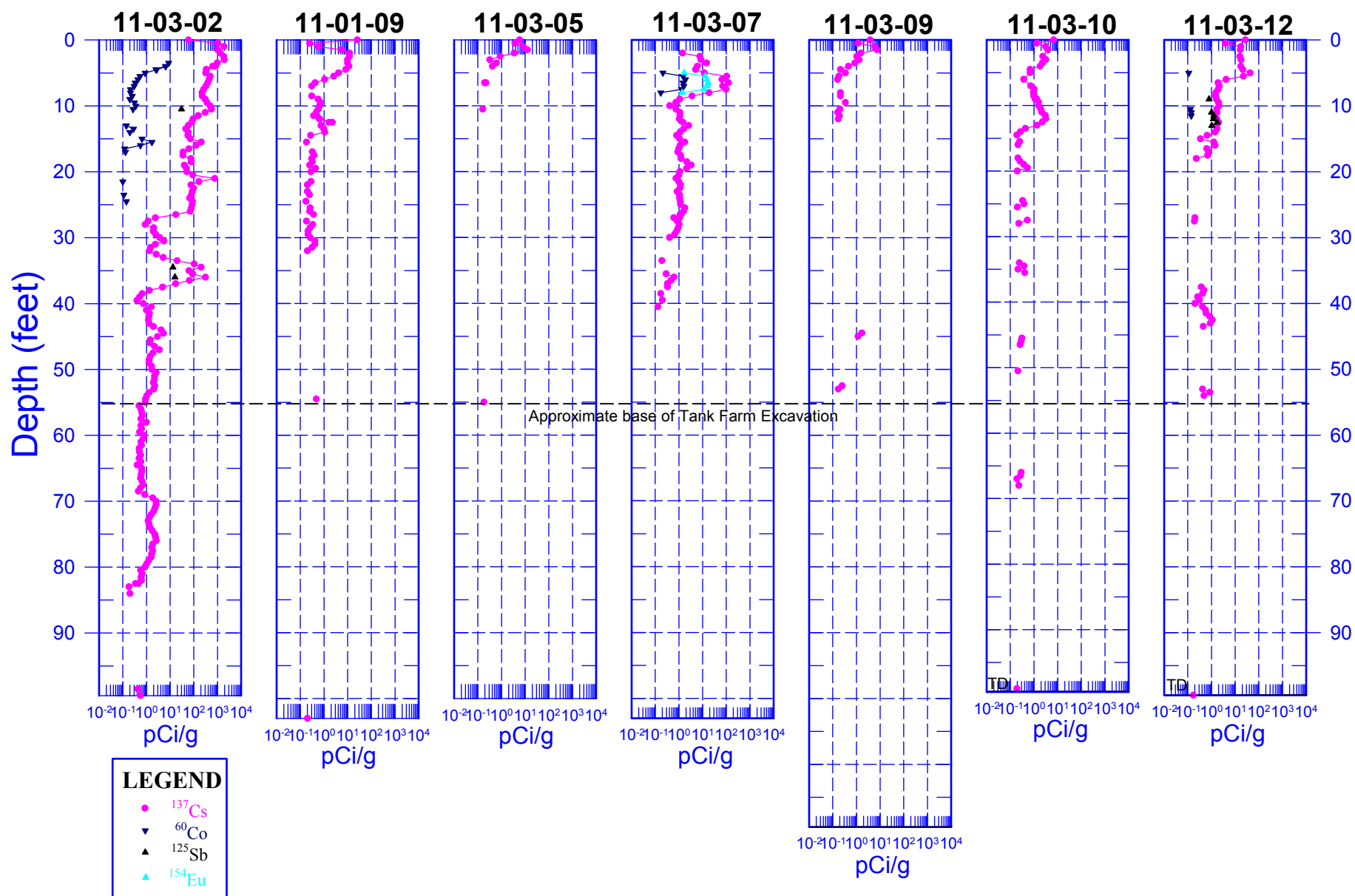


Figure 2
241-AX-103 baseline Data
manmade radionuclides

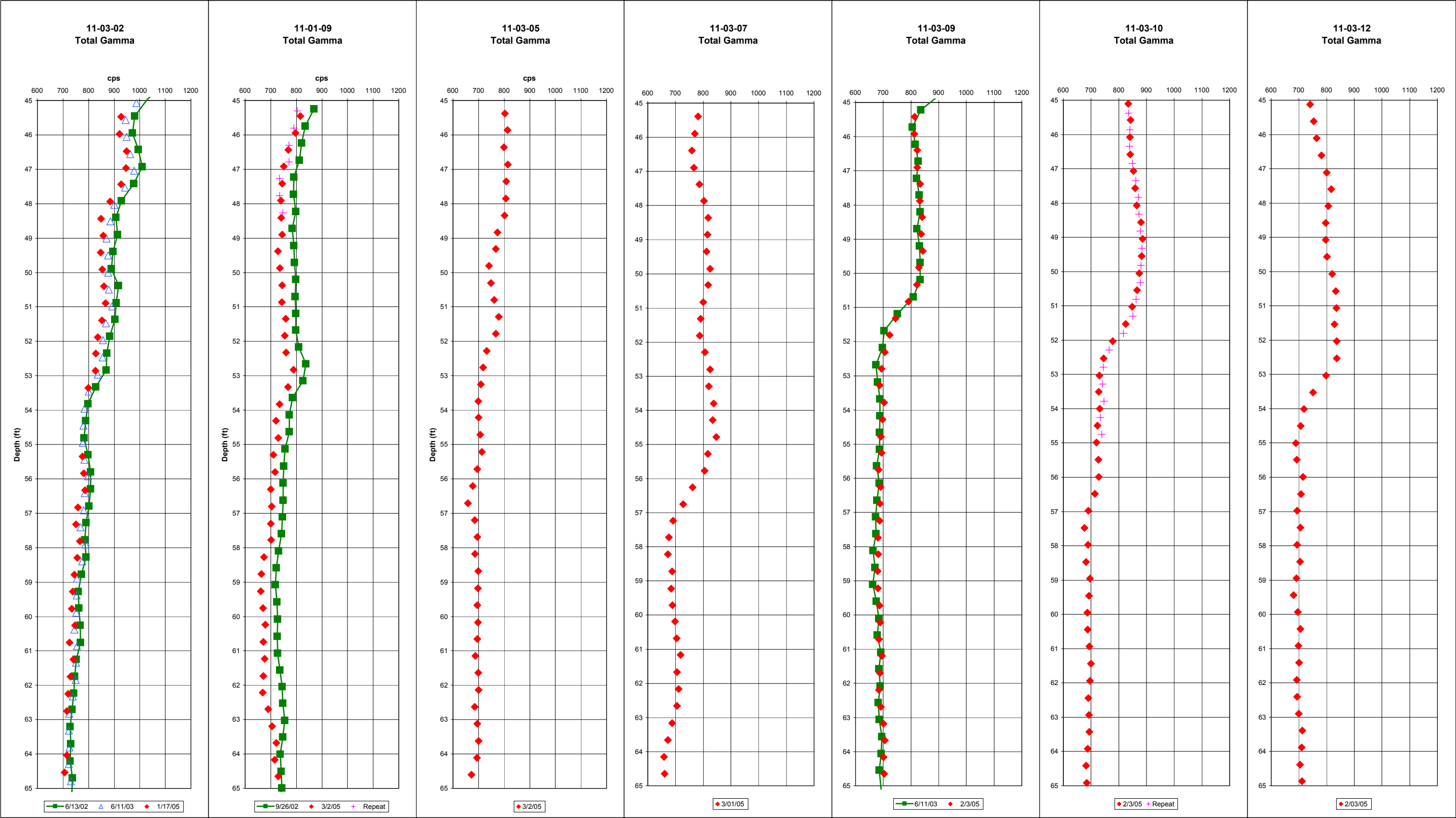


Figure 3
Summary of RAS Data

Borehole 11-03-02

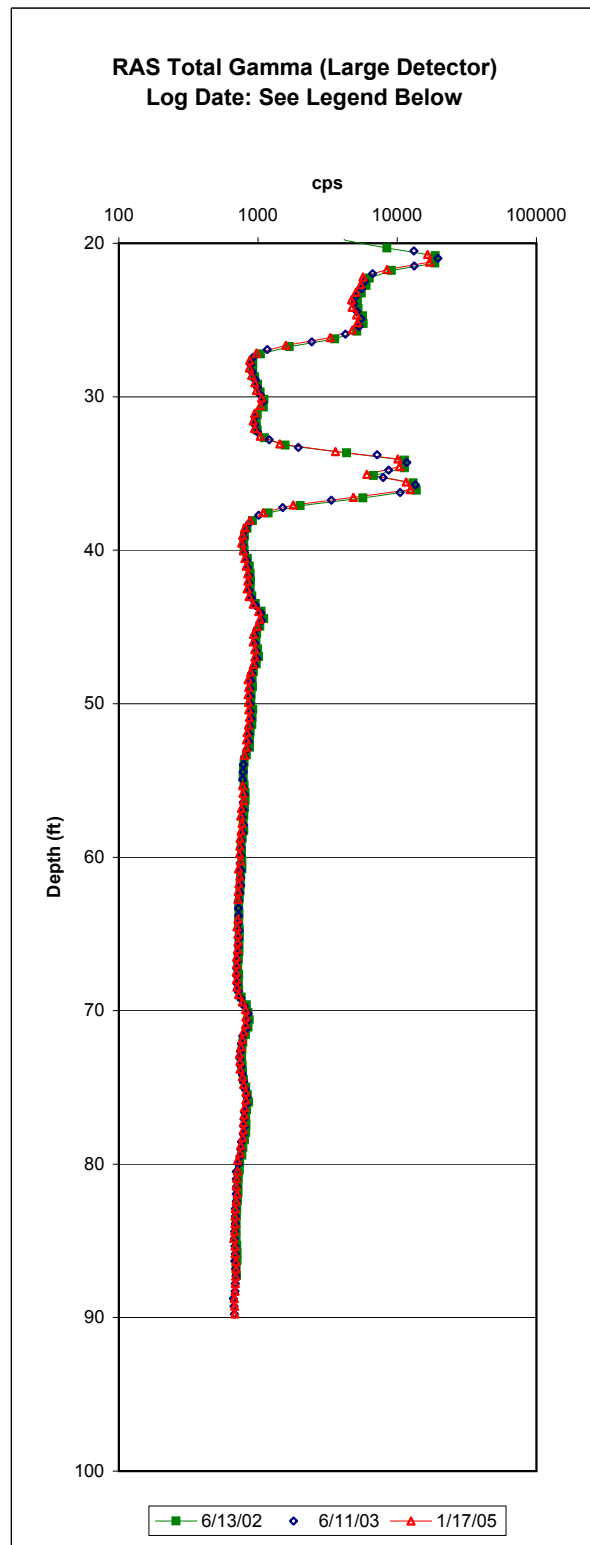
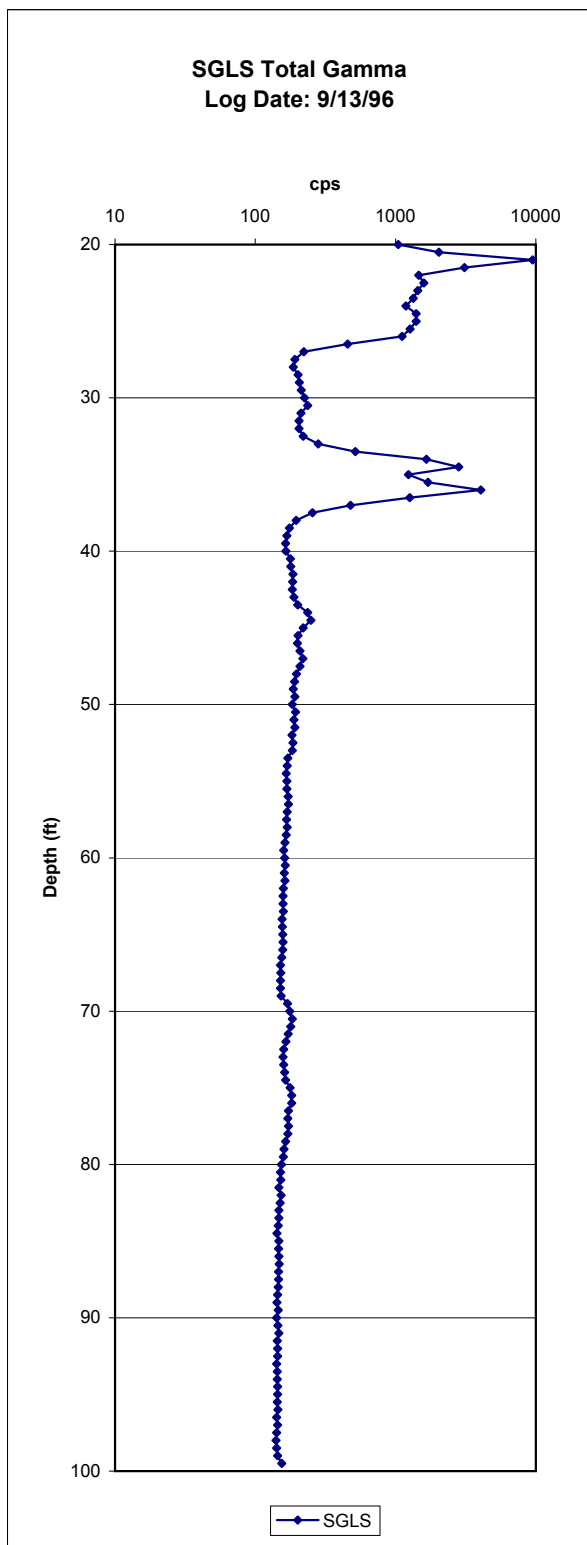


Figure 4

Borehole 11-01-09

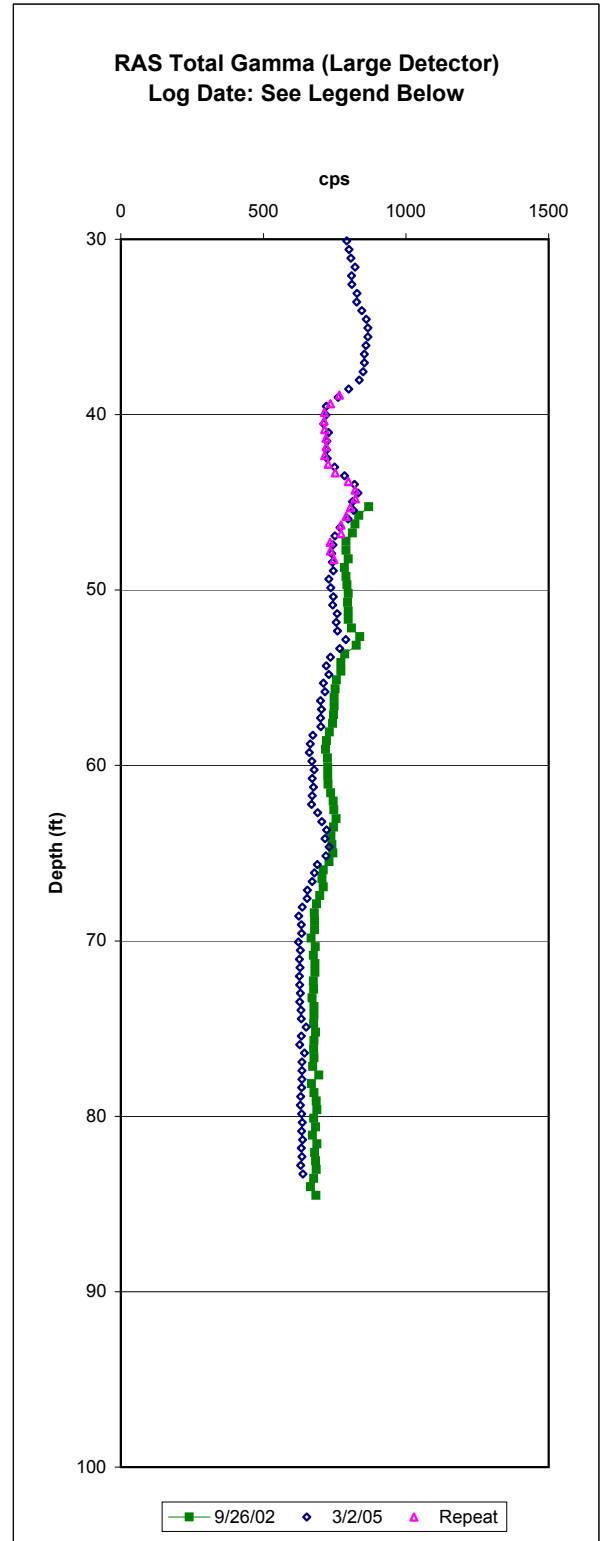
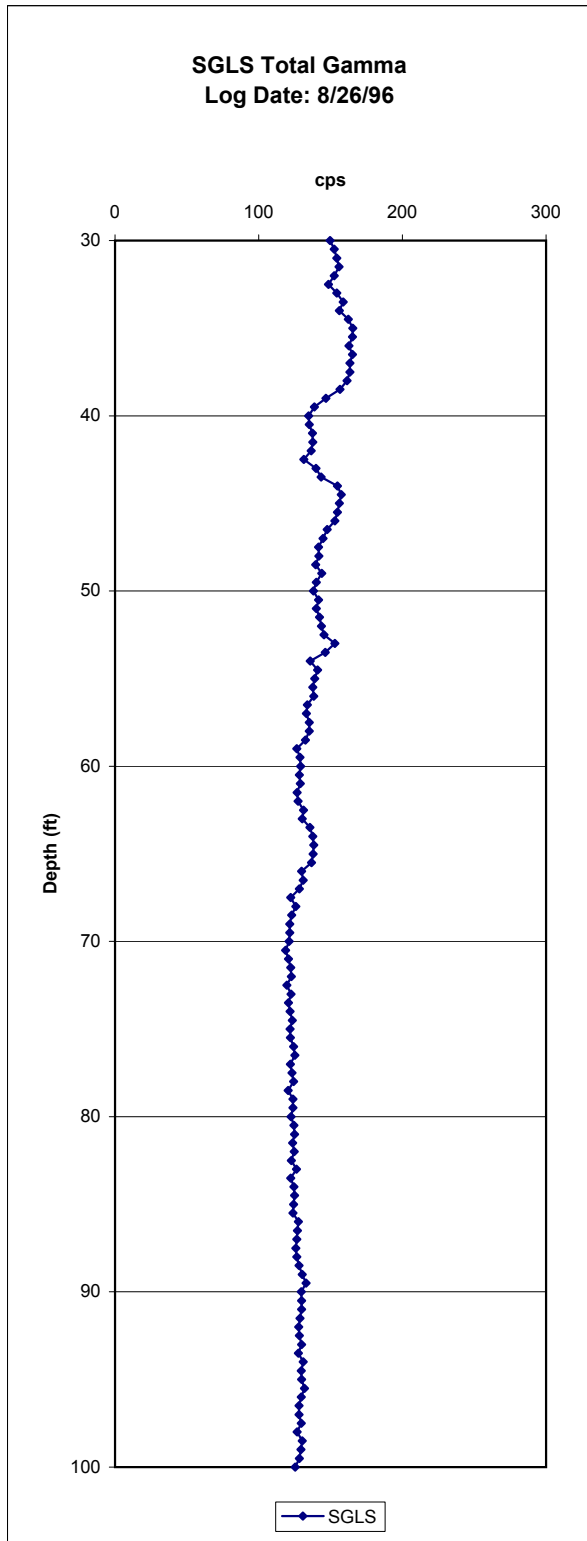


Figure 5

Borehole 11-03-05

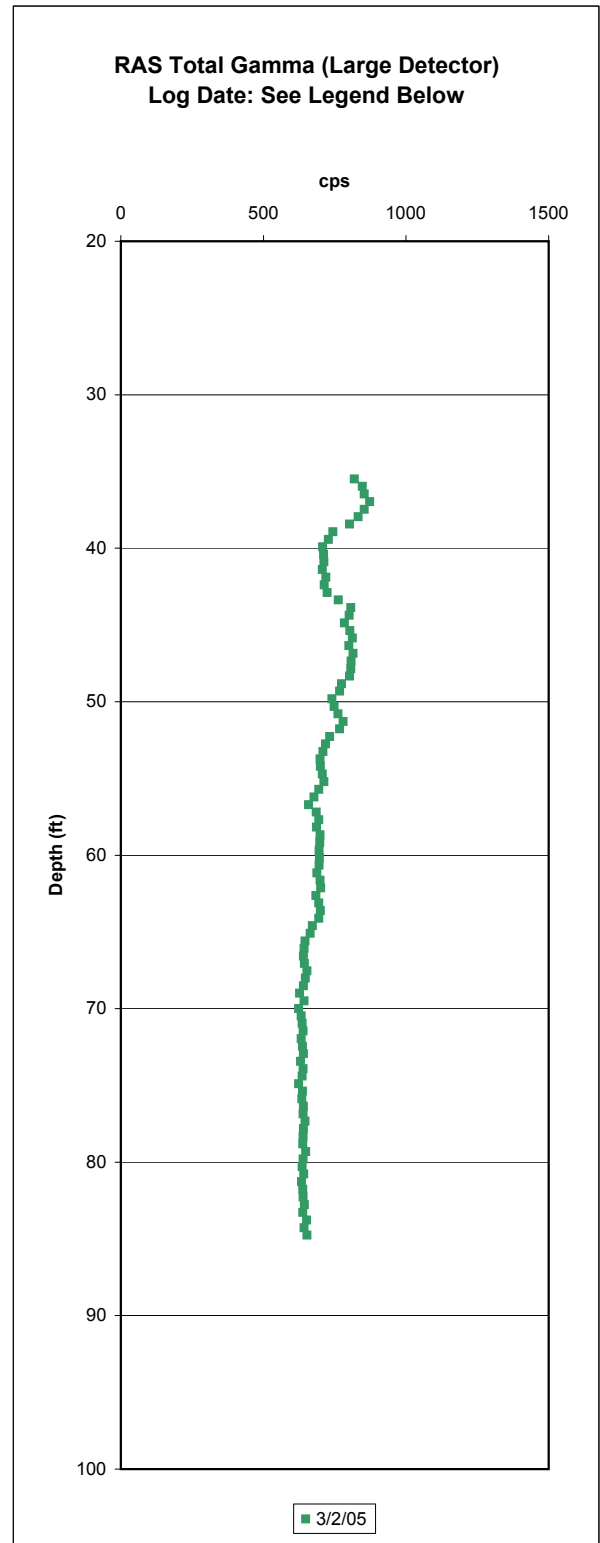
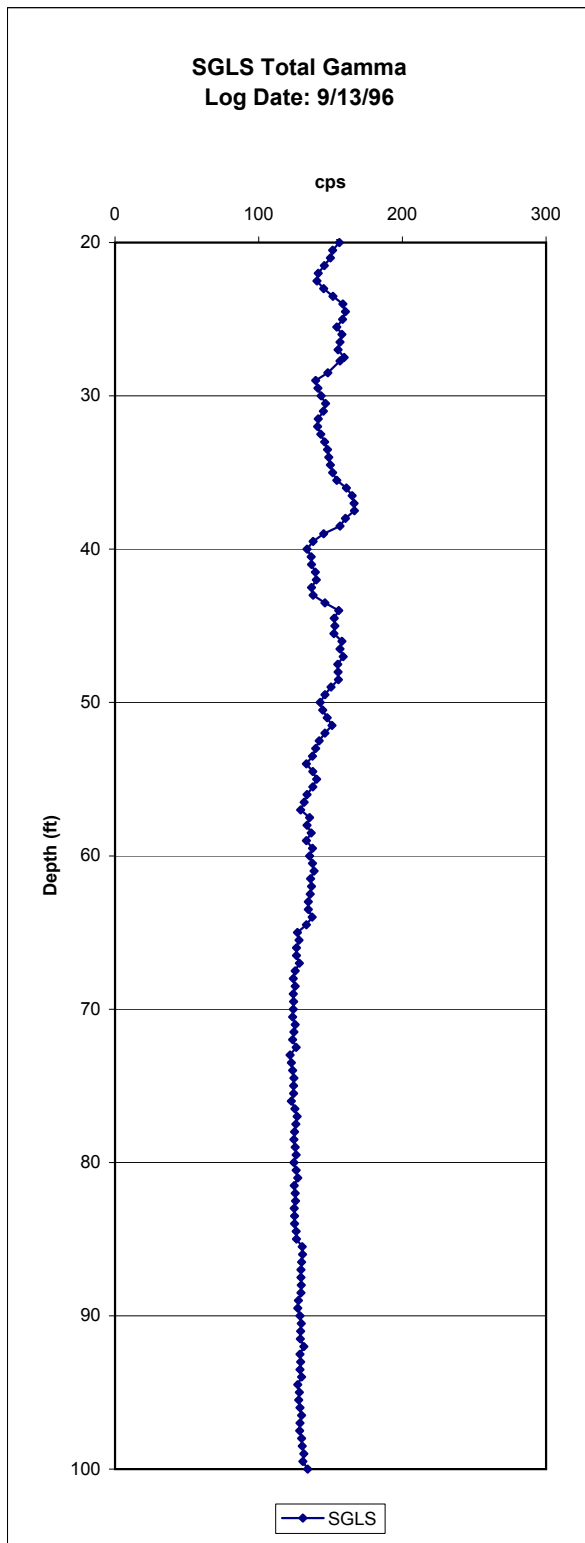


Figure 6

Borehole 11-03-07

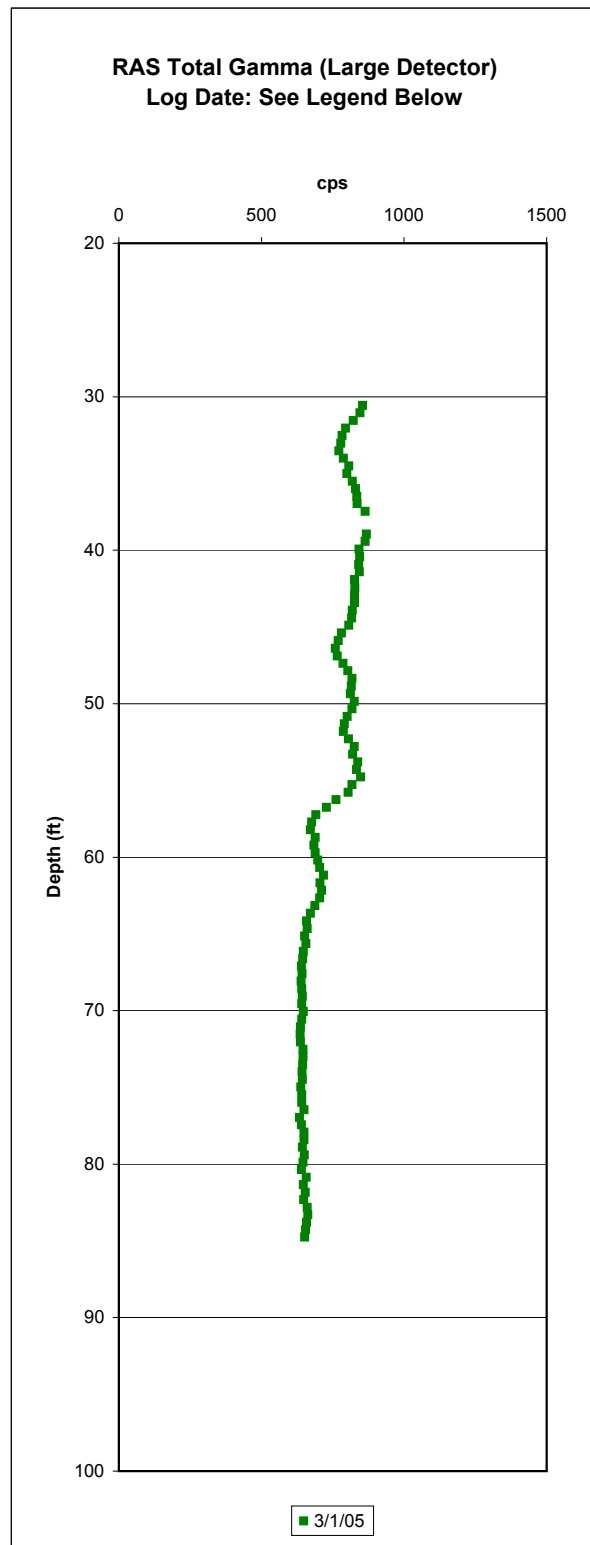
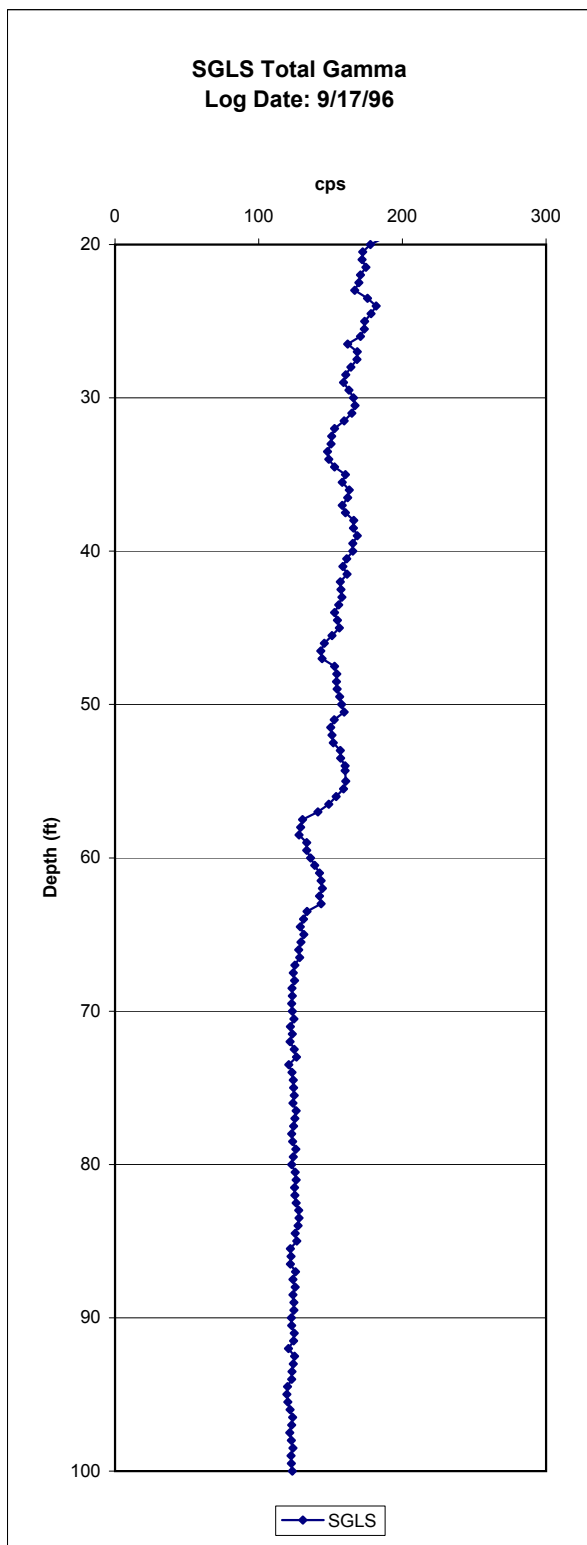


Figure 7

Borehole 11-03-09

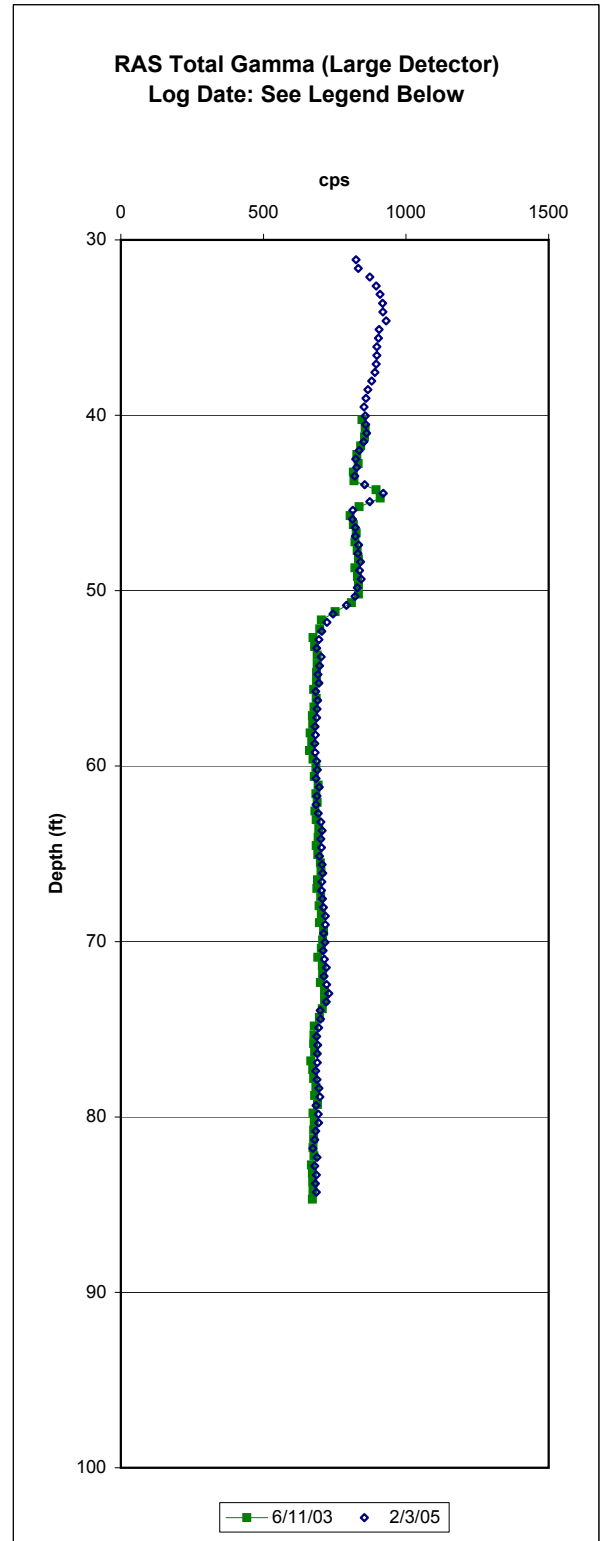
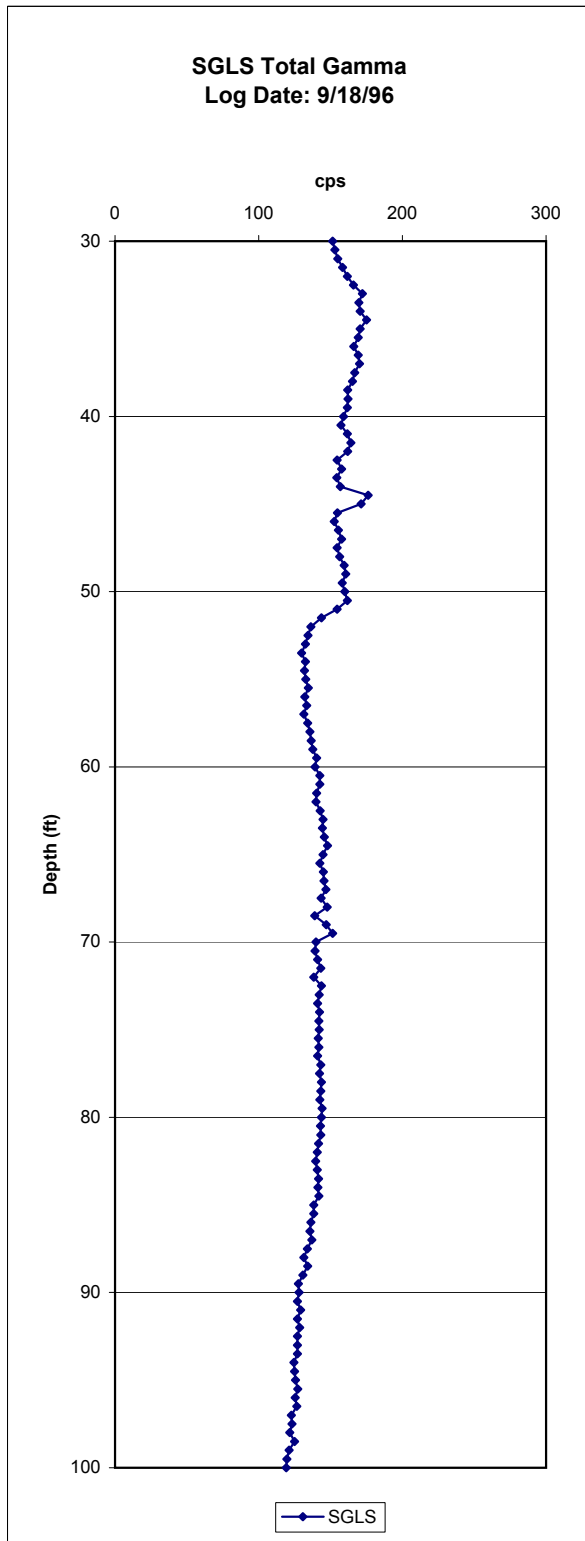


Figure 8

Borehole 11-03-10

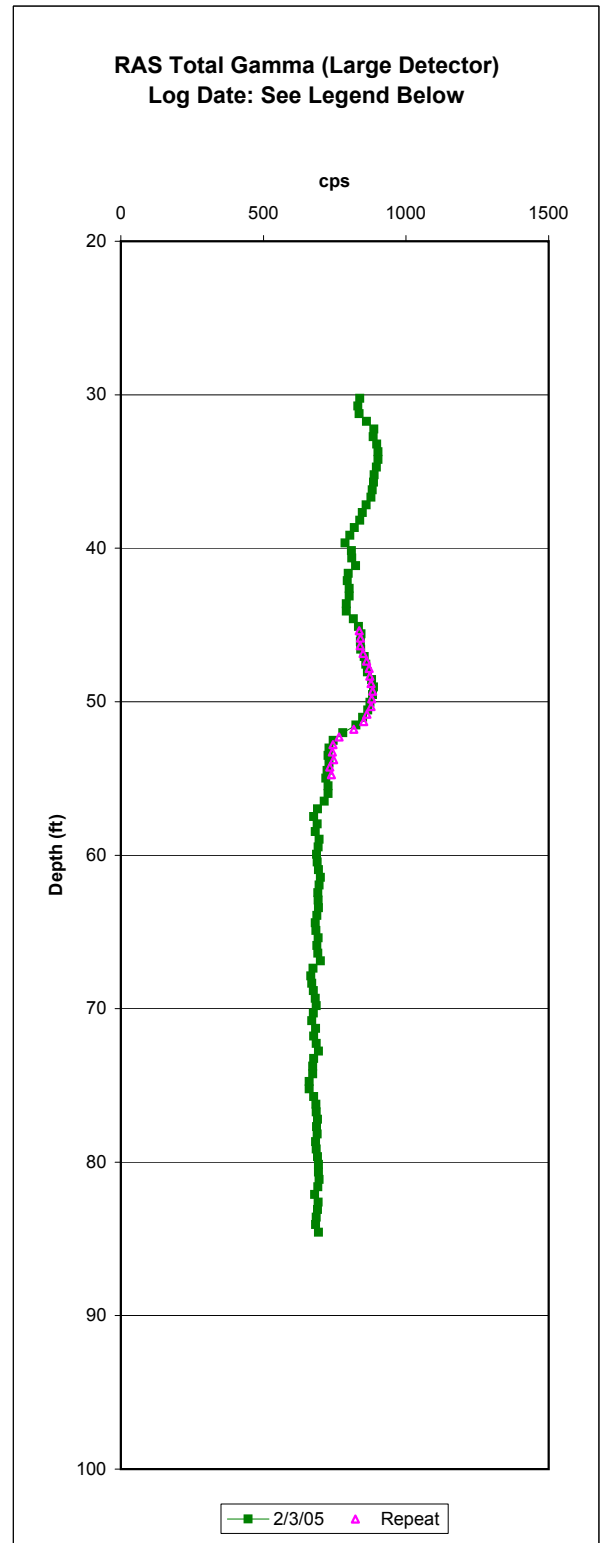
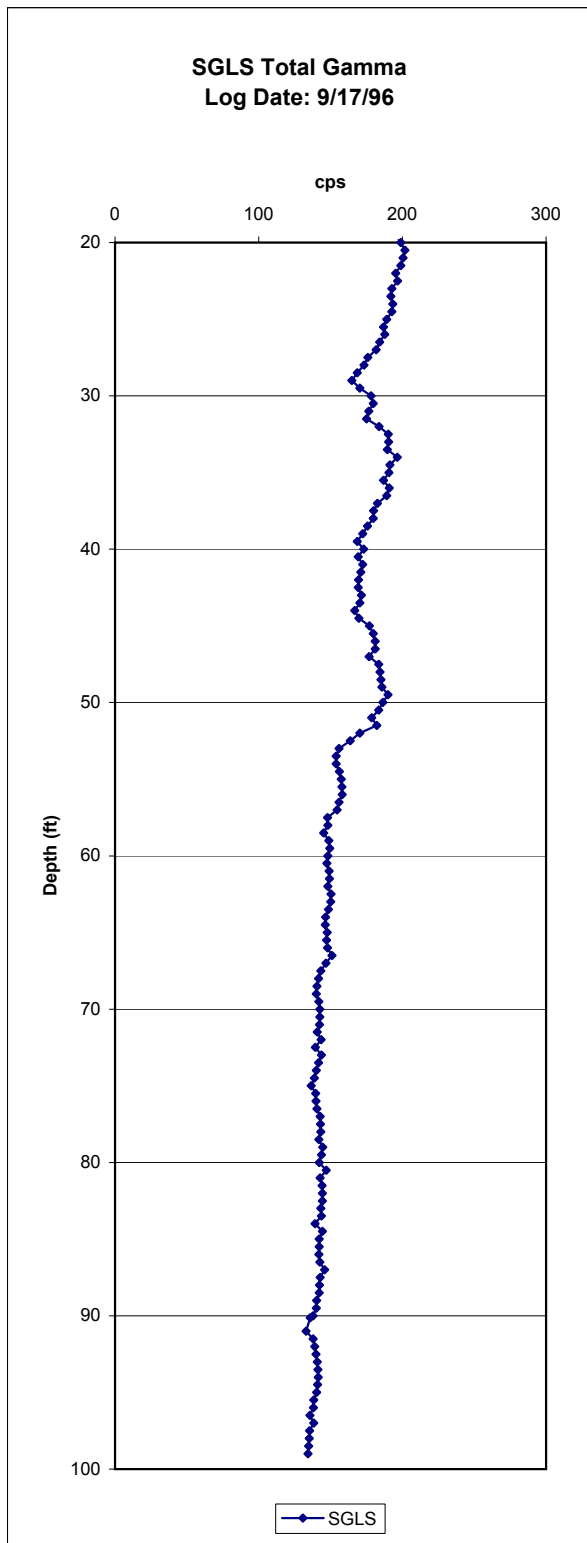


Figure 9

Borehole 11-03-12

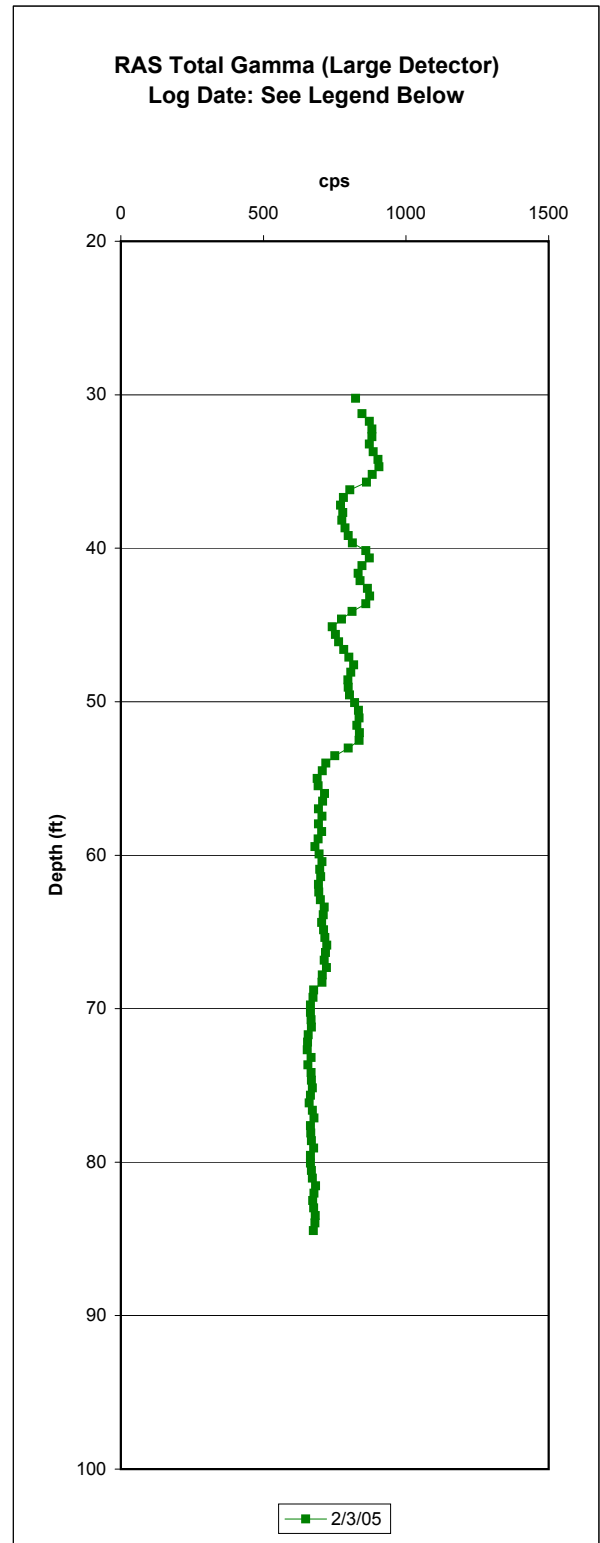
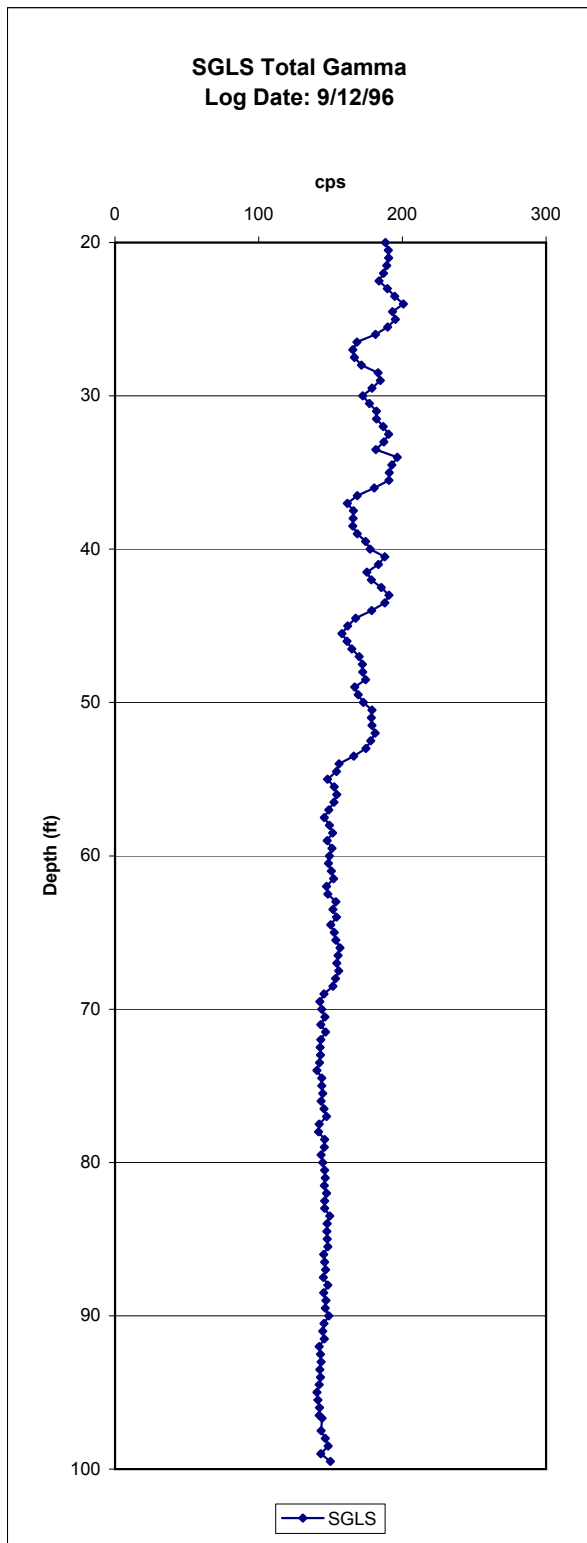


Figure 10

Appendix F
Boreholes Projected for Retrieval Monitoring
During the Third Quarter of FY 2005

Table F-2. Boreholes Projected for Retrieval Moisture Logging During the 3rd Quarter of FY 2005

Borehole Number	Tank	Top	Bottom	Footage	Next Event Date	Last Event Date	Projected 3rd Qtr. Events	Total Events (to date)	Comment
30-03-01	C-103	0	124	124	TBD	NA	1	0	No moisture logging performed to date.
30-03-03	C-103	0	97	97	TBD	NA	1	0	No moisture logging performed to date.
30-03-05	C-103	0	99	99	TBD	NA	1	0	No moisture logging performed to date.
30-03-07	C-103	0	96	96	TBD	NA	1	0	No moisture logging performed to date.
30-03-09	C-103	0	98	98	TBD	NA	1	0	No moisture logging performed to date.
30-06-04	C-106	0	129	129	12/12/04	11/12/04	1	7	Possible moisture increase 45-53 ft
40-02-01	S-102	0	129	129	02/11/05	01/12/05	1	2	None
40-02-03	S-102	0	98	98	02/11/05	01/12/05	1	2	None
40-02-05	S-102	0	97	97	02/17/05	01/18/05	1	2	None
40-02-07	S-102	0	95	95	02/12/05	01/13/05	1	2	None
40-02-08	S-102	0	99	99	02/02/05	01/03/05	1	2	None
40-02-10	S-102	0	100	100	02/04/05	01/05/05	1	2	None
40-02-11	S-102	0	100	100	02/10/05	01/11/05	1	2	None
40-03-03	S-103	0	122	122	01/21/05	12/22/04	1	2	None
40-09-06	S-109	0	98	98	01/15/05	12/16/04	1	5	Possible moisture increase 40-56 ft
40-11-08	S-111	0	96	96	12/31/04	12/01/04	1	5	None
40-11-09	S-111	0	98	98	01/20/05	12/21/04	1	4	Poss. moist. increase 23-45 & 49-51 ft
40-12-02	S-112	0	99	99	01/19/05	12/20/04	1	5	Possible moisture increase 32-55 ft
40-12-04	S-112	0	126	126	01/01/05	12/02/04	1	6	Possible moisture increase 53-55 ft
40-12-06	S-112	0	144	144	01/05/05	12/06/04	1	5	Possible moisture increase 36-49 ft
40-12-07	S-112	0	96	96	01/06/05	12/07/04	1	5	Possible moisture increase 23-43 ft
40-12-09	S-112	0	99	99	01/07/05	12/08/04	1	5	Possible moisture increase 36-50 ft
			Total Projected 3rd Quarter Events =				22		

Appendix G
Retrieval Monitoring System (RMS)
Operational Test Plan

Retrieval Monitoring System (RMS) Operational Test Plan DRAFT

S.M. Stoller Corp.
March 2005

1.0 Introduction

In 1994, the U.S. Department of Energy (DOE) Richland Operations Office (DOE-RL) requested the DOE Grand Junction Office (GJO), Grand Junction, Colorado, to perform a baseline characterization of gamma-emitting radionuclides in the vadose zone at all Hanford single-shell tank (SST) farms using high resolution spectral gamma-ray logging methods in existing boreholes surrounding the tanks. In 1998, Congress established the Office of River Protection (ORP) at Hanford, an autonomous organization that reports directly to DOE Headquarters. ORP is responsible for managing all aspects of the Tank Waste Remediation System (TWRS) project, including characterization of the vadose zone potentially impacted by the SSTs. The responsibility for the baseline characterization project, originally under the auspices of DOE-RL, was transferred to ORP in December 1998.

The baseline characterization project provided evidence that gamma-emitting radionuclides have migrated within the vadose zone beneath the tanks in the past and may be continuing to migrate. In response to these findings, ORP authorized MACTEC-ERS and its successor S.M. Stoller Corp. (Stoller) to establish and manage a spectral gamma monitoring program within the single-shell tank farms at Hanford that is performed via logging in the existing monitoring boreholes. The Radionuclide Assessment System (RAS) has been used since FY 2001 to perform this monitoring.

In FY 2003 ORP's focus changed from stabilizing the existing waste in the tanks to waste retrieval from the tanks. This change in focus also redirected the RAS's scope from routine monitoring to leak detection and mitigation (LDMM) in support of the waste retrieval projects. The LDMM requirements also enlisted the use of the neutron moisture logging system (NMLS) to assess any potential moisture movement through the vadose zone that may be attributed to the waste retrieval process. Both logging systems are currently required to fulfill the LDMM requirements for the retrieval projects. Stoller proposed during FY 2003 that a logging system capable of collecting gamma and moisture data simultaneously be procured to support the retrieval projects. This system would reduce the cost of the monitoring for the retrieval projects and free the RAS and NMLS systems to perform the work for which they were originally intended.

Stoller was given the approval to procure the Retrieval Monitoring System (RMS) during FY 2004. Stoller evaluated several existing portable small-diameter logging systems. The system manufactured by Mount Sopris was identified as the best fit for retrieval monitoring purposes. A formal test plan is required to assess all aspects of this system against performance criteria prior to its initial use for the retrieval monitoring program.

2.0 Purpose

This operational test plan specifies tests to determine the RMS response and overall performance under field conditions. Individual components of the system will be tested under various conditions and their performance evaluated. The major test issues include detector response, depth control, verification spectra, data handling, and logging speed. The results of the tests will be utilized to establish routine operational and data handling procedures.

3.0 System Description

The Retrieval Monitoring System (RMS) consists of a portable winch and electronics console, operated from a ruggedized laptop computer. The surface equipment weighs approximately 150 pounds, and is powered from a Honda 2000W inverter-type generator. The downhole sonde consists of a combination of a total gamma sonde and a neutron moisture sonde. The sondes are 1.5 inches in diameter, with a combined length of about 8 ft, and a combined weight of about 22 pounds.

The gamma detector is the Mount Sopris 2GHF-1000 “triple gamma” sonde. This sonde measures gamma activity with three different detectors. The most sensitive detector is a 1.5-in.-long NaI crystal and photomultiplier tube. Two different pairs of Geiger-Mueller tubes are installed above the NaI detector. The count rate output for the ZP1200 G-M detector pair is about 1% that of the NaI detector, and the count rate output of the ZP1320 G-M detector pair is about half that of the ZP1200 detectors. This sonde has been used successfully to determine ore grade for U_3O_8 concentrations as high as 20%. Counts from all detectors are concurrently recorded. The data are digitized in the sonde and transmitted to the surface via the digital modem/power supply.

The neutron sonde (CPN DX Neutron Probe) is a modified Campbell Pacific Nuclear soil moisture gauge. This probe has been modified to attach to the bottom of the 2GHF-1000 “triple gamma” sonde. The signal from the CPN probe is a pulse output with the pulses being negative voltage value with respect to the cable armor. This signal from the CPN probe is then sent to a DX pulse counting card where the counts per second are combined digitally and sent up the cable through a 2SMA modem section. The modified sonde will contain a 50-mCi AmBe source, with a source to detector spacing of 3 in. (7.5 cm). The detector and electronics are not affected by the modification.

Additional documentation for the individual components comprising the RMS and the logging software are located in the system component notebook. Modifications, repairs, and maintenance records for the RMS are documented in the RMS maintenance notebook. Both notebooks shall be available for reference and documentation during this test procedure.

4.0 Test Procedures

The following sections describe the procedures required to complete each of the components of the operational test plan. The results from these tests shall be described on the summary sheets provided for the specific tests. Any deviations from these procedures shall also be noted on the summary sheets. Appendix B presents examples of these summary sheets.

4.1 Field Verification Test

Field verification measurements are required prior to and after a logging event by a particular tool to verify that the tool is functioning within given parameters.

The bottom tool shall be placed in the source pig and the gamma source jig placed over the gamma detectors and the tool allowed to count for a specified time. After the time has elapsed the count rates from each detector shall be compared with acceptance criteria to determine if they fall within the specified limits. Acceptance criteria will be developed during the system's annual calibration and will not be available during this test. The purpose of this test is to determine if the verification procedure is acceptable, if the pig will produce adequate neutron scattering, and whether the gamma source is sufficient for all detectors.

Several items shall be checked during this process. First, does the software allow the operator to identify the spectra as a pre-cal and/or post cal? Will the file save properly? Does the software allow the operator to extract count rates in the field?

4.2 Depth Control Test

Depth control is vital when evaluating possible contaminant and/or moisture movement in the vadose zone. There are several components to consider when testing the depth measurement and recording systems. There is an optical depth encoder on the winch that provides signals to a digital readout on the MXG II Logger and the PC computer so the software can also track the current depth value. To test these systems a steel tape shall be attached to the zero point on the sonde. The tool, with centralizer, shall be zeroed at the top of the casing and run into the borehole. The tool will be stopped every 10 ft and the value from the digital readout recorded, as well as the depth readout from the computer and the measured depth from the steel tape. This shall be repeated every 10 ft to the bottom of the borehole and every 10 ft withdrawing from the borehole. When the tool is back to the zero-depth reference (top of casing), a measurement shall be made of the difference between the tool zero reference and the top of the casing. All depth readings should be within 0.10 ft.

The winch must also be able to hold the logging tool at a constant depth while the winch control is in the stop position. This is necessary for the system to make stationary measurements in a borehole. The tool should not creep downward or upward while the 10-ft depth measurements are taken.

4.3 Winch Speed Control Test

Most routine logging will be performed in the continuous logging mode. Speed control is vital for producing consistent count times in the continuous logging mode. Winch speed control will be tested during this phase. The operator must be able to adjust and control the hoist speed while moving the tool. The hoist must be able to maintain speeds as low as 1.0 ft/min and as fast as 20 ft/min. The speed of the hoist can be monitored on the laptop. At 1.0 ft/min the speed should not fluctuate more than ± 0.1 ft/min and at 20 ft/min the speed should not fluctuate more than ± 2 ft/min. A stopwatch shall be used to check the speed during this test.

This test will be performed in conjunction with the detector response test described in Section 4.5, "Detector Response Test." The tool shall be positioned at the top of the borehole and lowered to a depth of 100 ft at 20 ft/min. The time to move the tool from 0.0 to 100.0 ft shall be recorded, as well as, the rate displayed by the computer. The distance moved divided by the time recorded by the stop watch will determine the average rate. Each log run for the detector response test will be started at 100 ft. The time of each log run and the logging speed during the detector response test shall also be recorded. The calculated rate must be within 10% of the rate displayed on the computer.

4.4 Log Header Test

Each log run will require an operator to fill in a log header using the computer. The log header contains vital information regarding the borehole, the logging system, and the log run. This test will evaluate the software required to perform this task. To begin this test the tool shall be positioned over the borehole and energized. The operator shall initialize the logging program and attempt to enter all borehole and logging information into the log header. While doing so, the operator shall note any errors or limitations in the software, ease of its use, and if entries in all fields are required. If a field is not required or is redundant, the software shall be modified to remove the field. Likewise, data fields will be added as necessary.

4.5 Detector Response Test

This is the final field systems check and will be used to test all detectors. This test will be performed in a borehole(s) to be determined by the Technical Lead. The selected borehole(s) shall be logged with the SGLS, NMLS, and HRLS logging systems prior to testing. This will provide the concentrations of various radionuclides and a moisture profile of the borehole(s).

The borehole(s) shall be logged with various parameters that will be determined by the technical lead. This will help determine the appropriate logging speed and data collection interval. A high rate section of the borehole(s) shall also be logged to determine the upper limit of gamma flux for the gamma detectors and the susceptibility of gamma interference with the neutron detector.

A 10-ft repeat section shall be logged with each tool after the appropriate logging speed and data collection interval have been selected. This will test the repeatability of the system.

To pass this portion of the test there should be no computer lock-ups during logging, and the total gamma and moisture profiles should mimic that of the profile provided during the SGLS and NMLS logging.

4.6 Data Handling Test

Log data shall be transferred from the field to the main office using the proposed protocol. The proposed protocol shall ensure that the data and any data sheets are transferred to the office and copied to the server within 24 hours of data collection. Feedback shall be provided by the office staff notifying the field staff that all data have been received and backed-up. A data analyst will process the data copied to the server to ensure that all files were transferred and that the data were not corrupted in the process.

5.0 Other Considerations

All other systems and components shall be evaluated during these tests. In particular the sheave wheel assembly, utility vehicle, the generator, and storage racks shall be examined closely for possible problems, and these problems shall be noted and corrected before the RMS is field deployed. The operator may make notes regarding the ergonomics of the system and make suggestions for improvements.

A test procedure outline is provided in Appendix A. This outline will be used as a guide by the logging engineers performing the individual tests in the field.

Some portions of this test may have to be repeated as problems are discovered and system repairs are made.

6.0 Test Conclusions

Upon completion of this test, all data sheets shall be compiled and a summary report prepared. The summary report will describe all deficiencies observed and their resolution. Recommendations will also be made to improve the system's performance. Sections should also be included discussing implementation of the routine operational and data handling procedures. Finally, the report will discuss any additional testing that should be performed for further evaluation of the RMS.

Appendix A

Test Procedure Outline

Test Procedure Outline

1.0 Field Verification Test

- Collect one 30-sec. verification file with the tool in the neutron pig and with the gamma jig positioned over the gamma detectors.

2.0 Depth Control Test

- Align the tool zero reference point with the top of the casing, set the computer and encoder depths to zero, and attach the steel tape.
- Run tool into borehole stopping every 10.0 ft to record digital readout from encoder, the depth readout from the computer, and from the steel tape.
- Repeat this process while withdrawing the tool from the borehole and return to the zero position (top of casing). Record the difference between the tool zero and the top of the casing.

3.0 Winch Speed Control Test

- Performed in conjunction with the Detector Response Test.
- Move the tool from 0.0 to 100.0 at 20.0 ft/min and record the time.
- Record the time required for each log run and the logging speed.

4.0 Log Header Test

- Power up system and enter log header information.

5.0 Detector Response Test

- Log entire borehole several times using various logging parameters provided by the Technical Lead.

6.0 Data Handling Test

- Transfer data collected from the Detector Response Test to the office using the proposed protocol.

Appendix B
Operational Test Results Summary Sheets

Depth Control Test Results

Date:

Logging Engineer:

Borehole:

Steel Tape Serial Number:

Detector Used:

Recorded/Measured Depths (ft)

Steel Tape

Optical Encoder Readout

Computer

Notes:

Return Error:

Signature:

Date:

Winch Speed Control Test			
Date:	Logging Engineer:	Borehole:	
Detector Used:			
10 - 110 ft	Rate from computer:	Time:	Rate:
110 - 10 ft	Rate from computer:	Time:	Rate:
Detector Used:			
10 - 110 ft	Rate from computer:	Time:	Rate:
110 - 10 ft	Rate from computer:	Time:	Rate:
Detector Used:			
10 - 110 ft	Rate from computer:	Time:	Rate:
110 - 10 ft	Rate from computer:	Time:	Rate:
Comments:			
Signature:		Date:	

Log Header Test Results	
Date:	Logging Engineer:
Note any bugs in software:	
Note data fields that are not required:	
Note additional data fields that need to be added:	
Comments:	
Signature:	Date:

Detector Response Test Results	
Date:	Logging Engineer:
Borehole:	Depth Interval:
Depth Start:	File Start:
Depth Finish:	File Finish:
Counting Time:	Logging Speed:
Sample Interval:	Depth Return Error:
Borehole:	Depth Interval:
Depth Start:	File Start:
Depth Finish:	File Finish:
Counting Time:	Logging Speed:
Sample Interval:	Depth Return Error:
Borehole:	Depth Interval:
Depth Start:	File Start:
Depth Finish:	File Finish:
Counting Time:	Logging Speed:
Sample Interval:	Depth Return Error:
Comments:	
Signature:	Date:

Field Verification Test Results		
Date:	Logging Engineer:	
Location of Test:		
NaI Detector Test		
File Name:	Time:	Counting Time:
Gross Counts:	Dead Time:	
ZP1200 G-M Detector Test		
File Name:	Time:	Counting Time:
Gross Counts:	Dead Time:	
ZP1320 G-M Detector Test		
File Name:	Time:	Counting Time:
Gross Counts:	Dead Time:	
CPN DX Neutron Detector Test		
File Name:	Time:	Counting Time:
Gross Counts:	Dead Time:	
Signature:		Date:
Geophysicist/Technical Lead:		Date: